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**Kresge et al.**

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(54) **AUTOMATIC WHEEL GRID**

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(21) Appl. No.: **17/852,937**

(57) **ABSTRACT**

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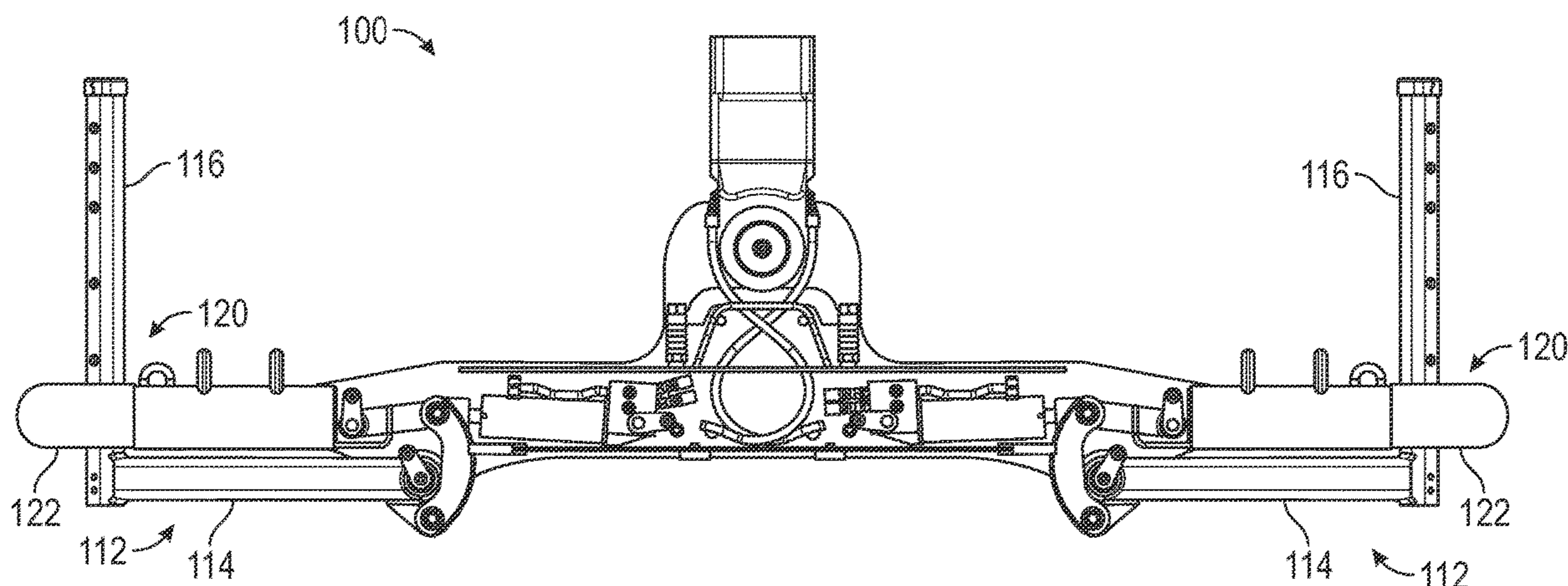
A wheel grid includes a crossbar configured to be coupled to a main boom of a wheel lift tow vehicle; two L-arms, each coupled to the crossbar at a respective pivot point and including an extension member and a wheel brace member; and a crossbar end coupled to each end of the crossbar and including a cantilevered portion, the crossbar ends each configured to engage a tire of a towed vehicle. The L-arms are configured to rotate into a stowed position in which each L arm is positioned under one of the cantilevered portions.

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**B60P 3/12** (2006.01)

(52) **U.S. Cl.**  
CPC ..... **B60P 3/125** (2013.01)

(58) **Field of Classification Search**  
CPC ..... B60P 3/125  
USPC ..... 414/563  
See application file for complete search history.

**15 Claims, 18 Drawing Sheets**



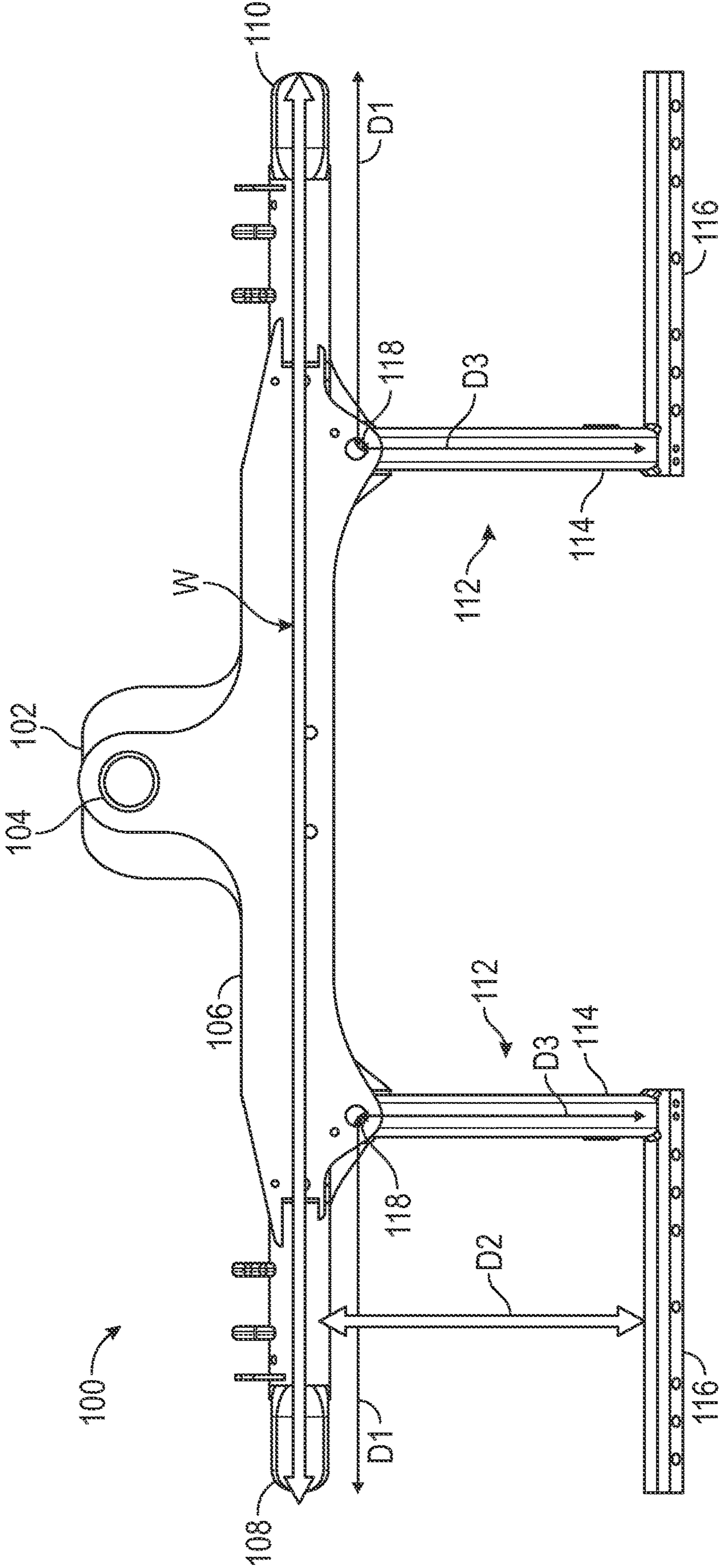


FIG. 1

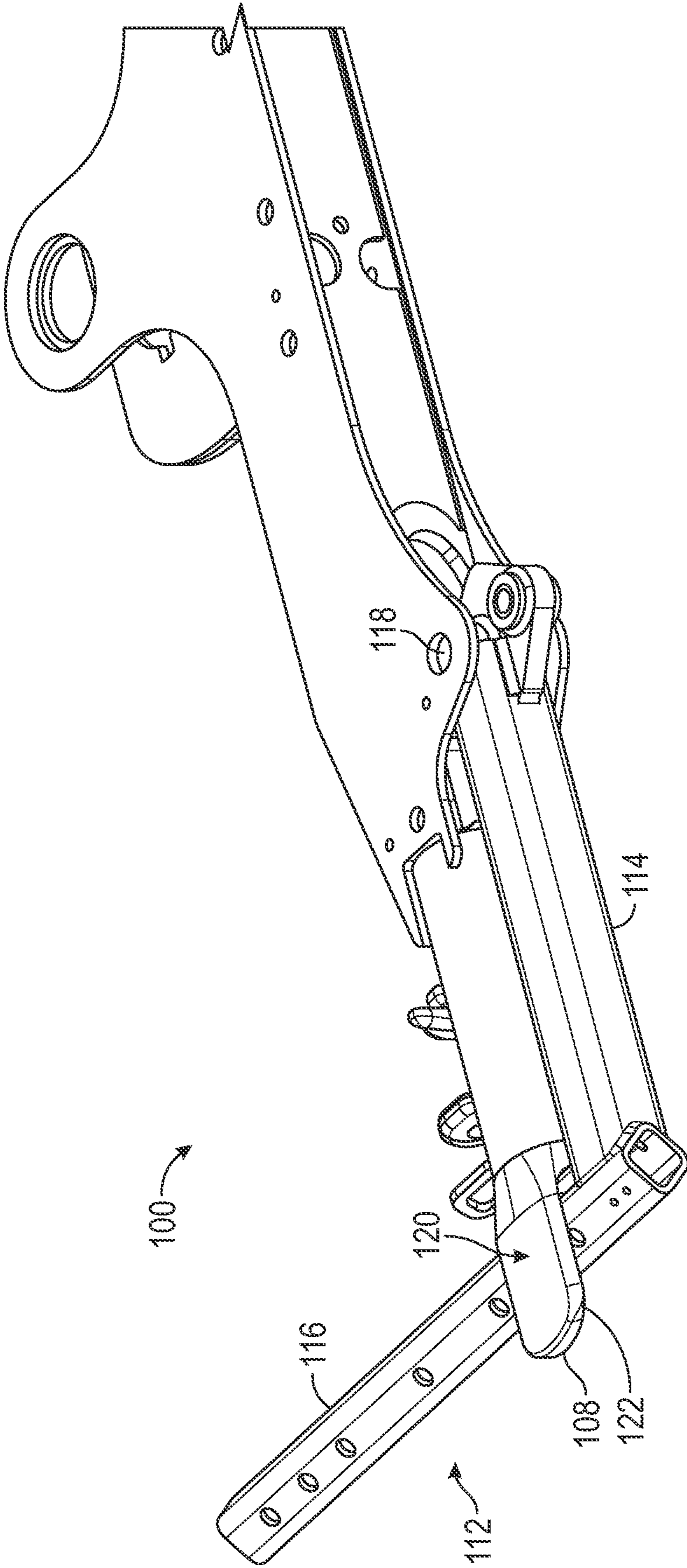


FIG. 2

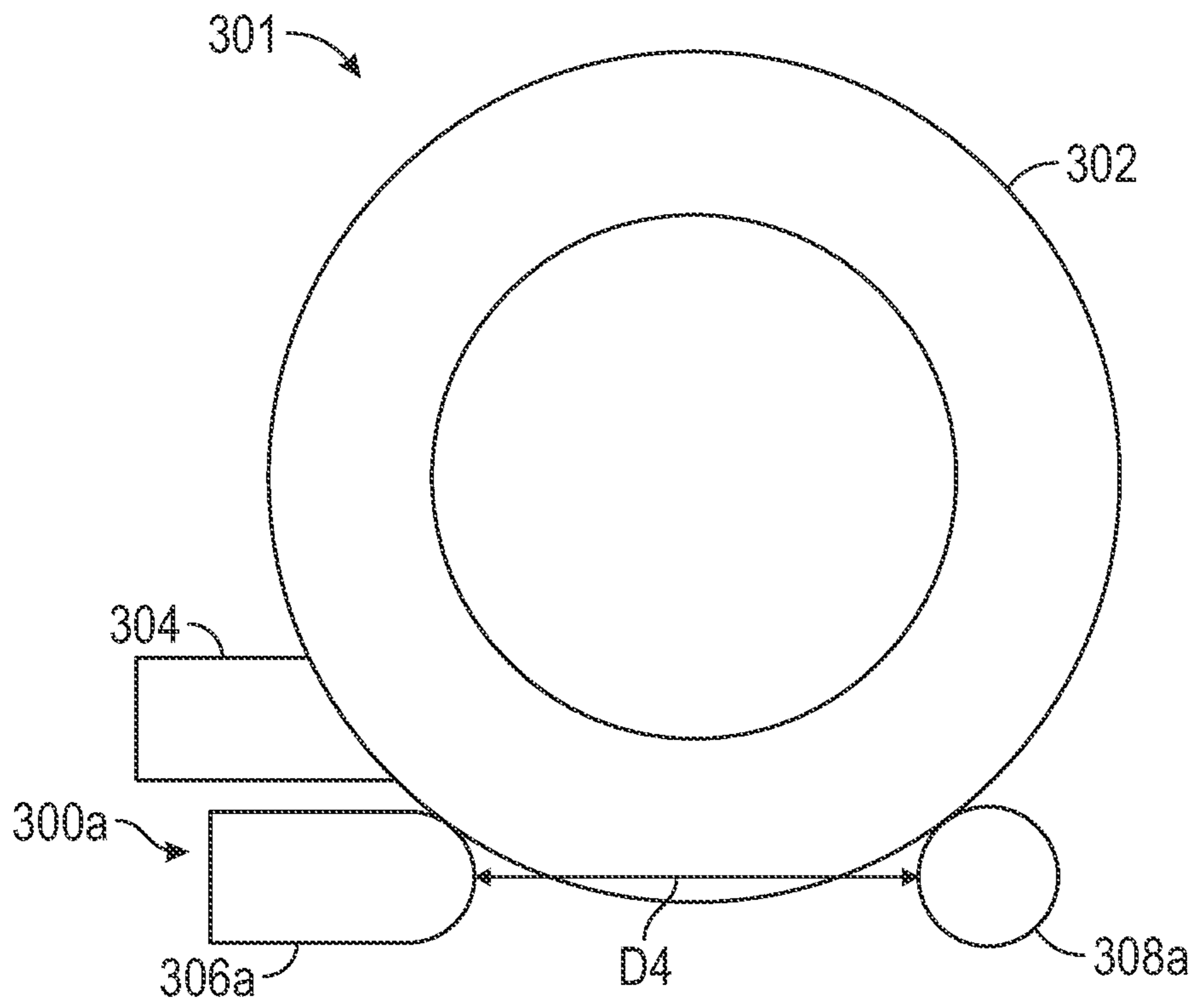


FIG. 3A

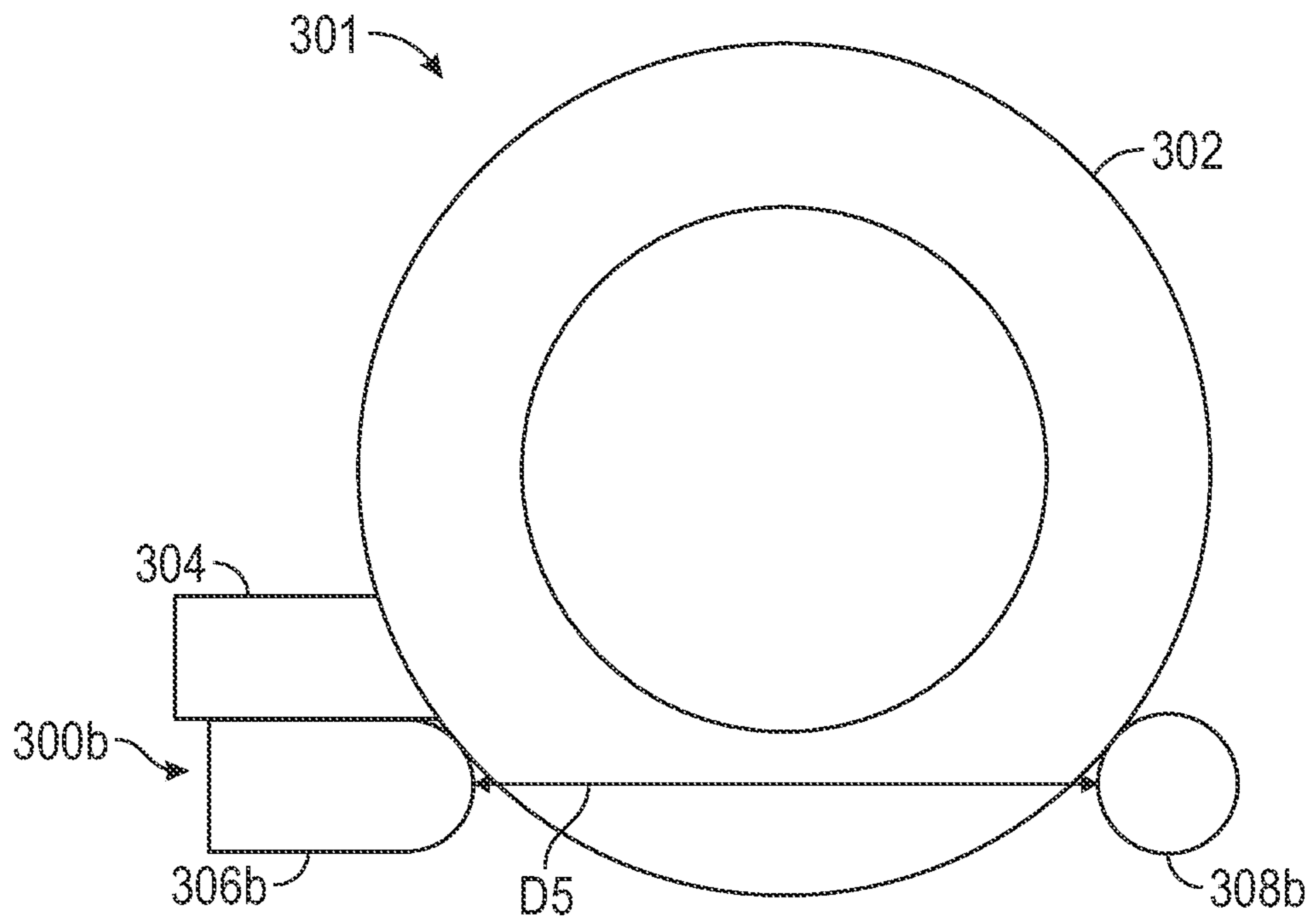


FIG. 3B

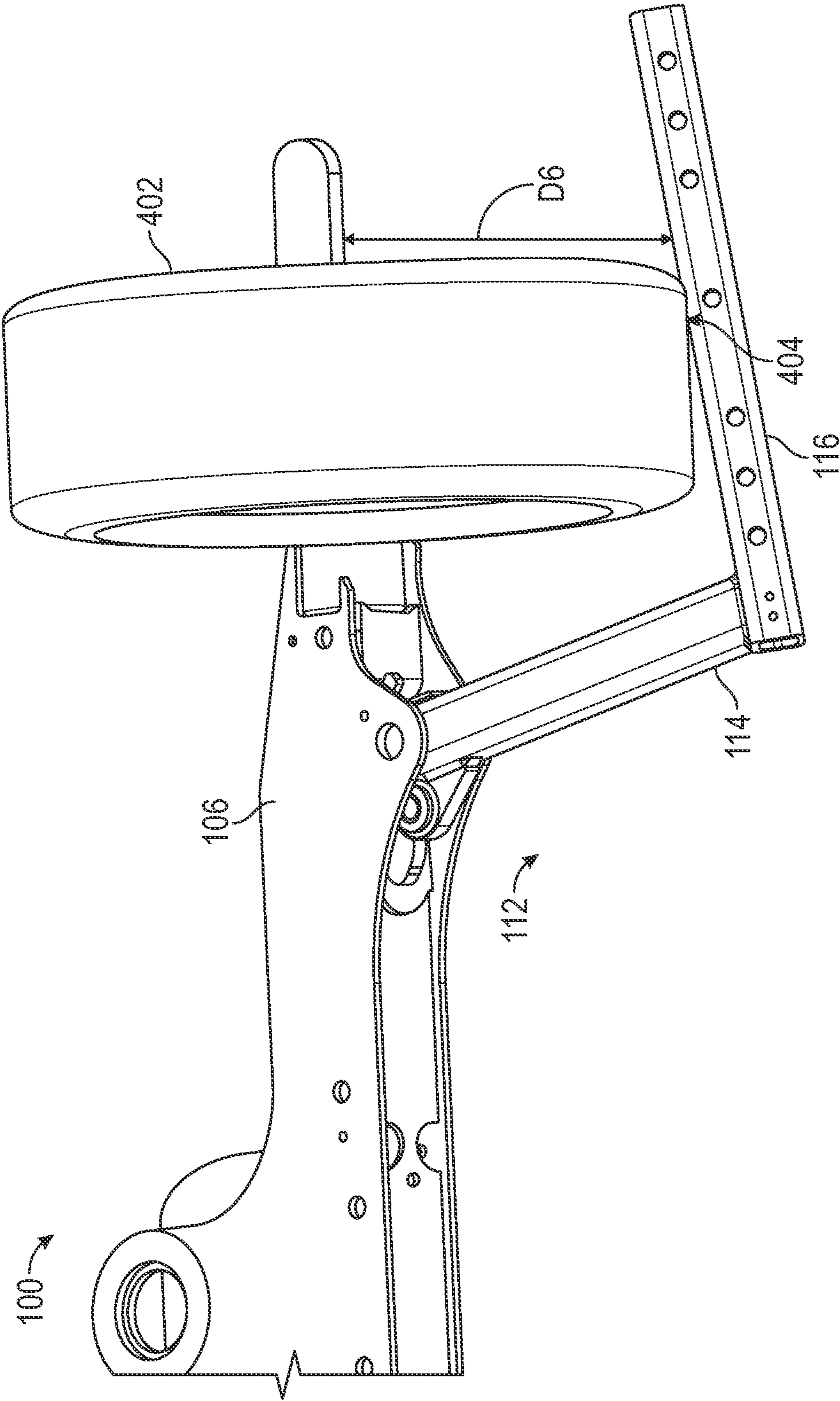


FIG. 4

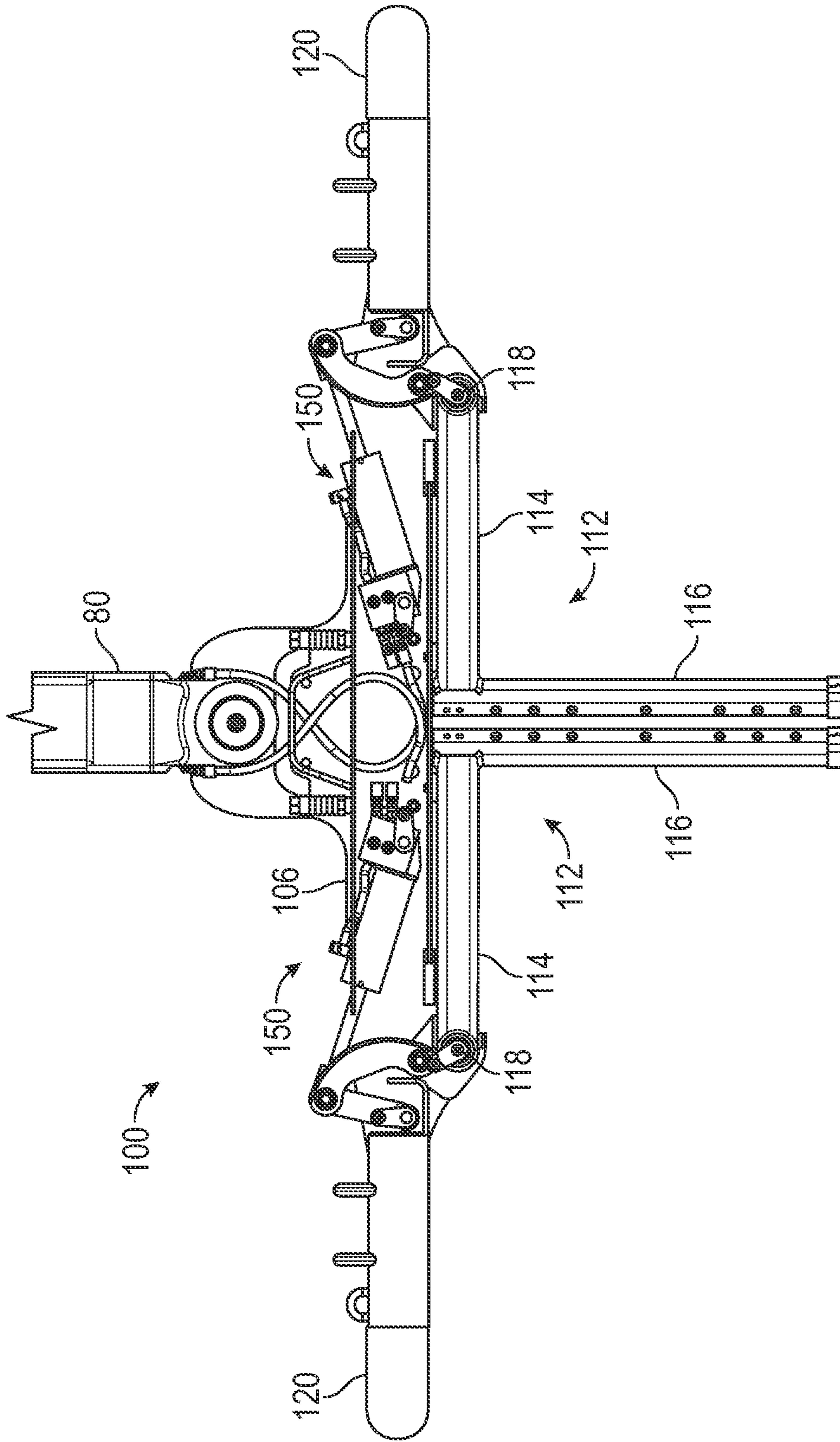


FIG. 5

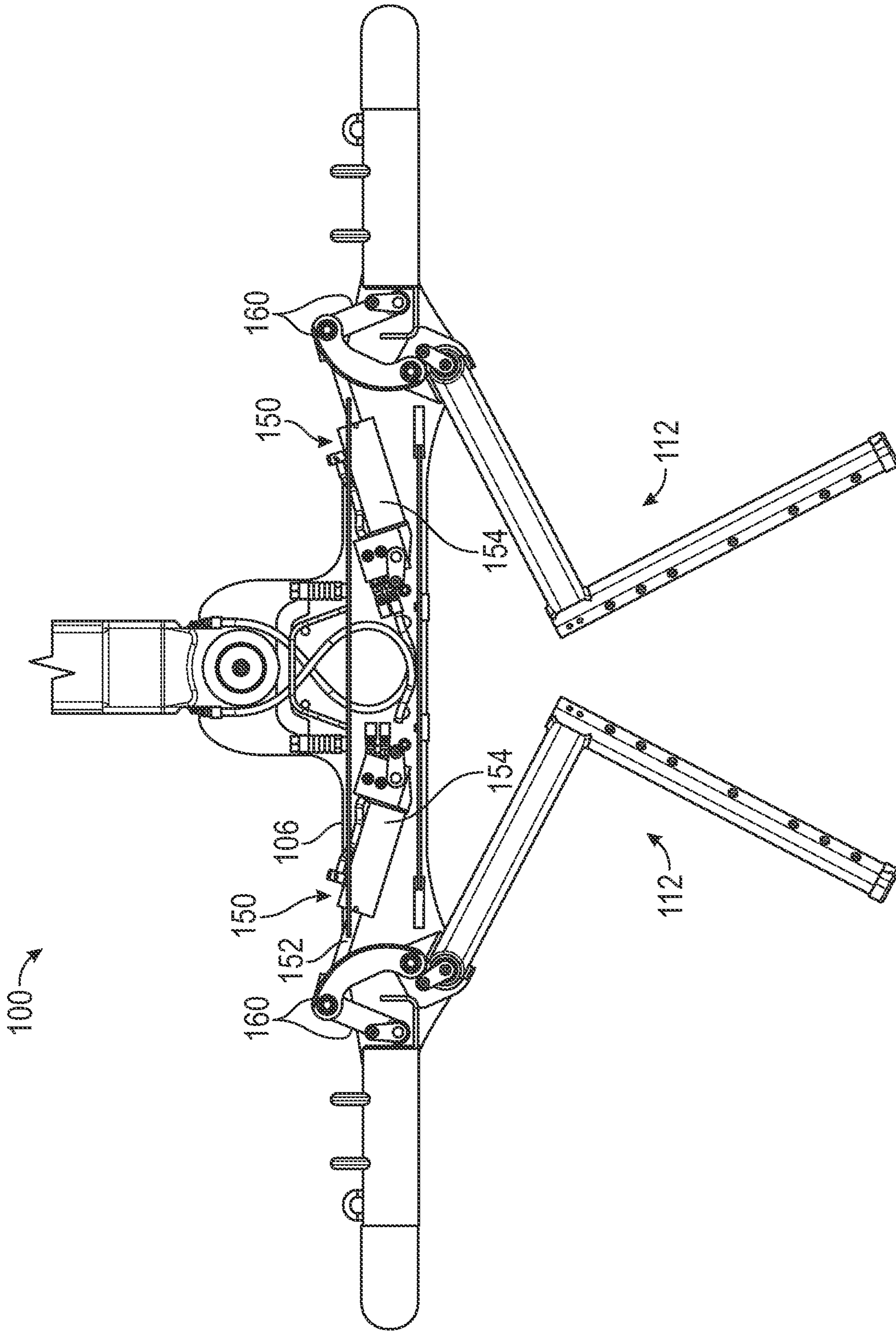


FIG. 6

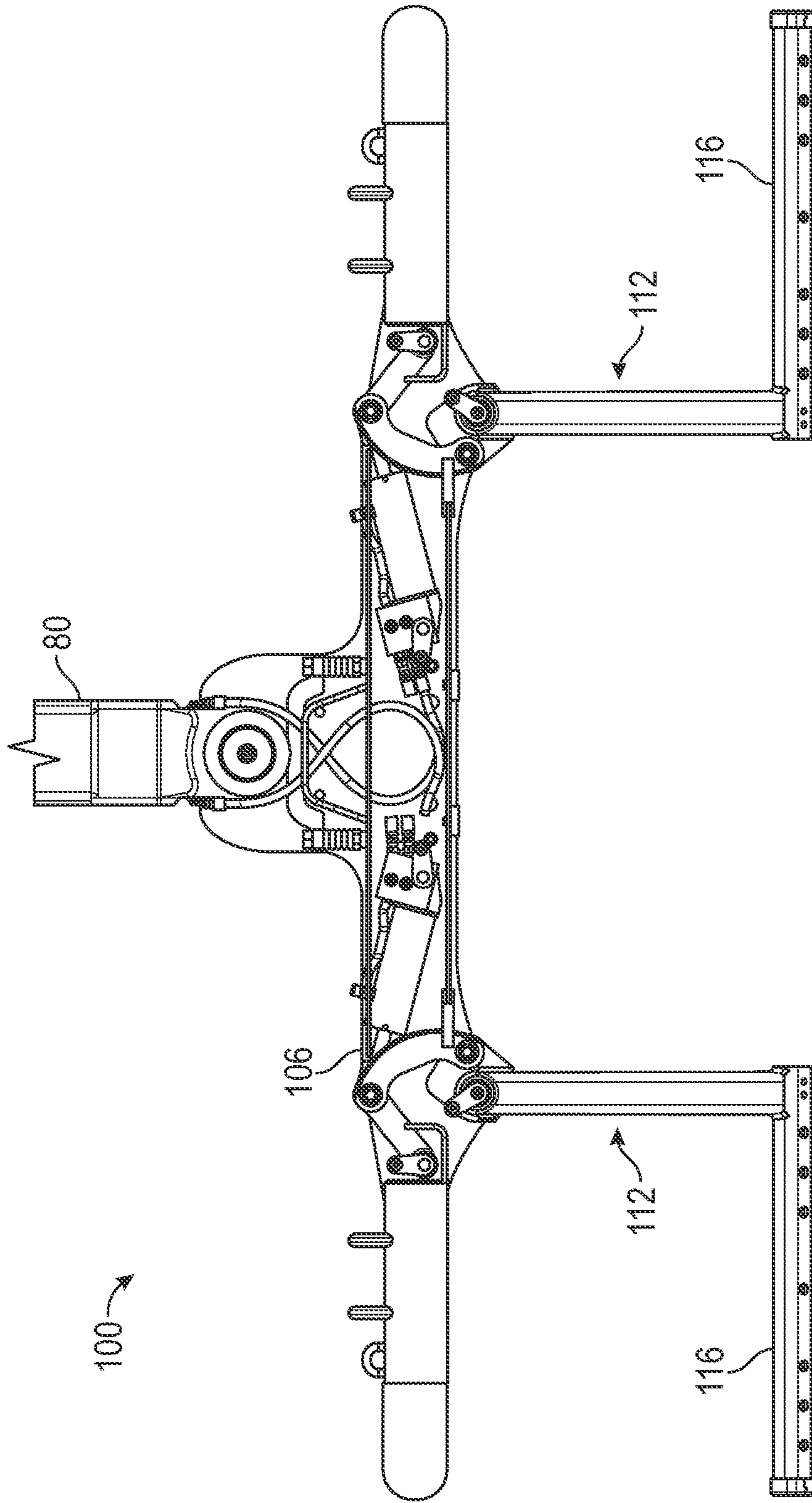


FIG. 7



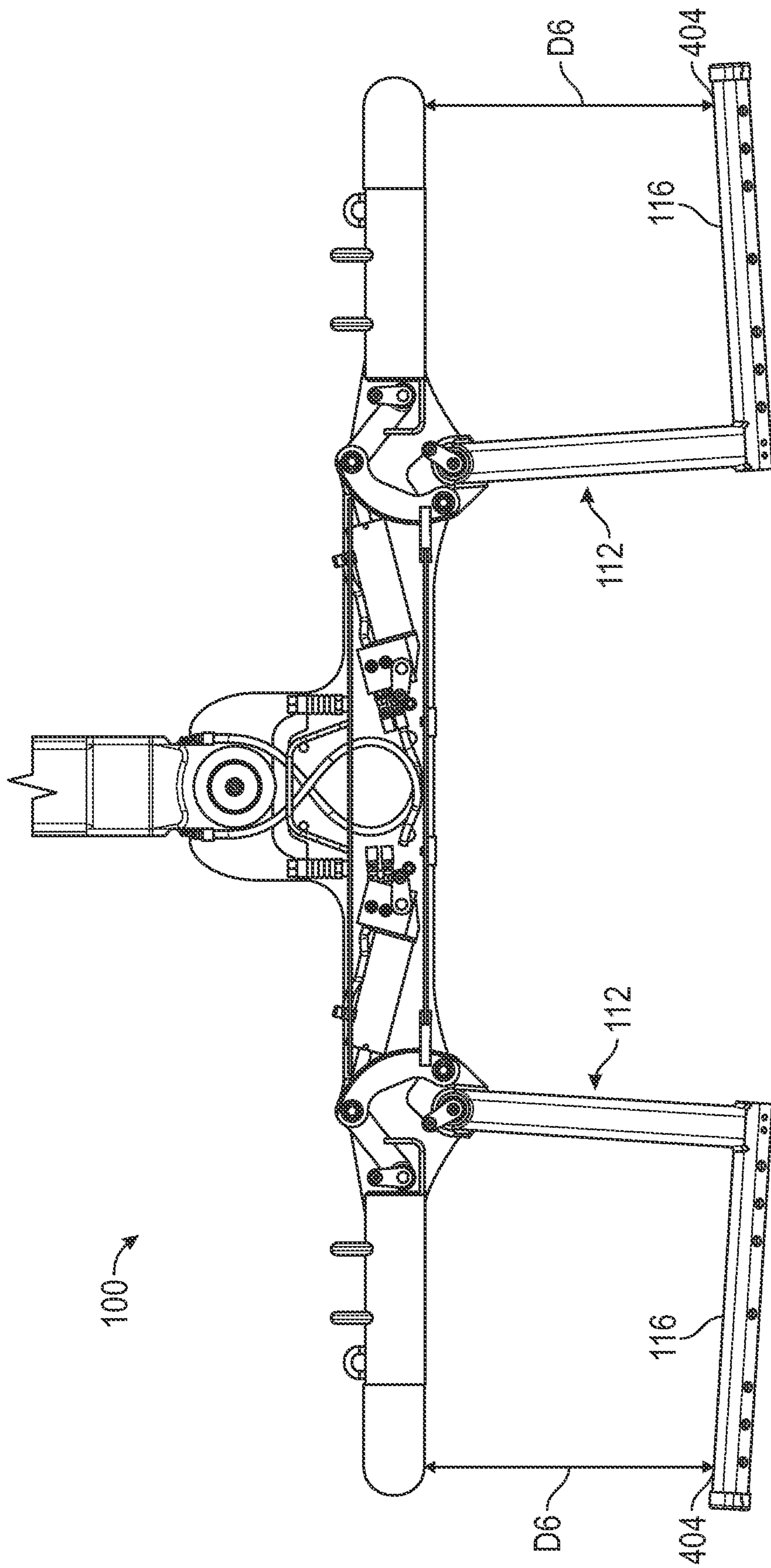


FIG. 8

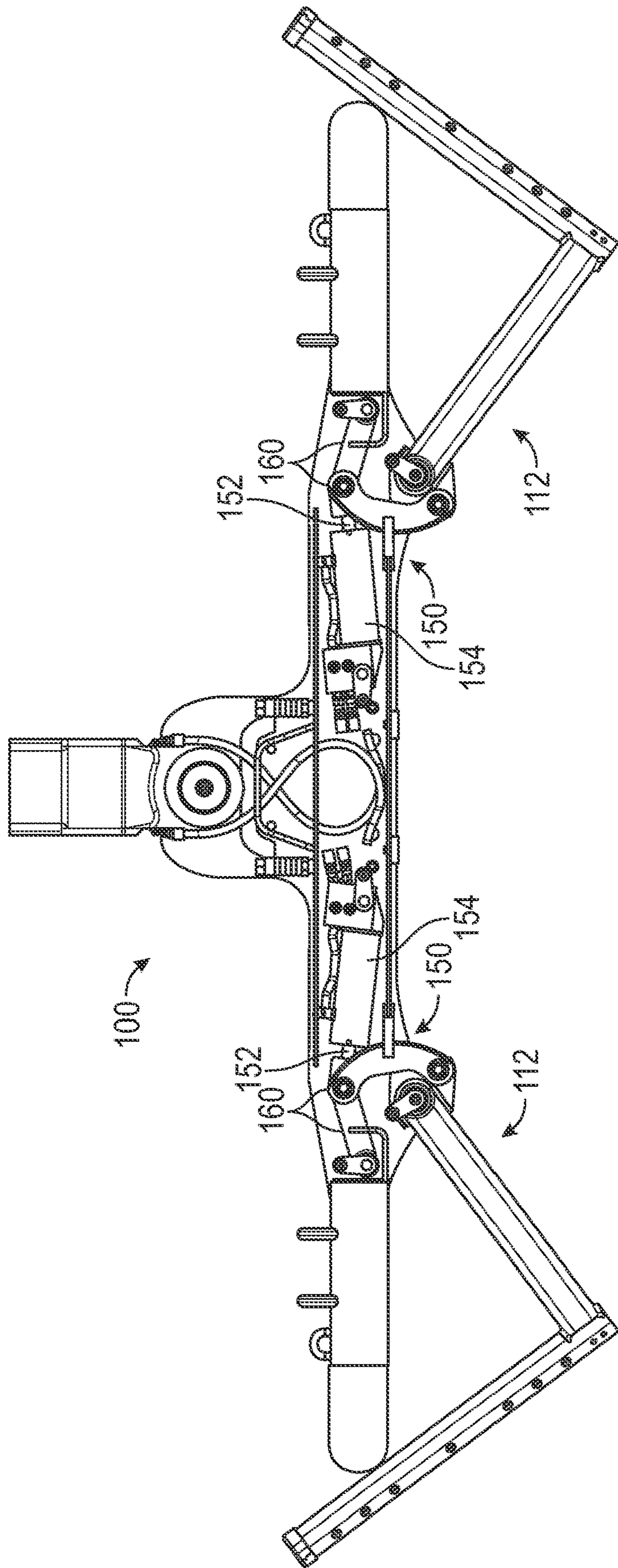


FIG. 9

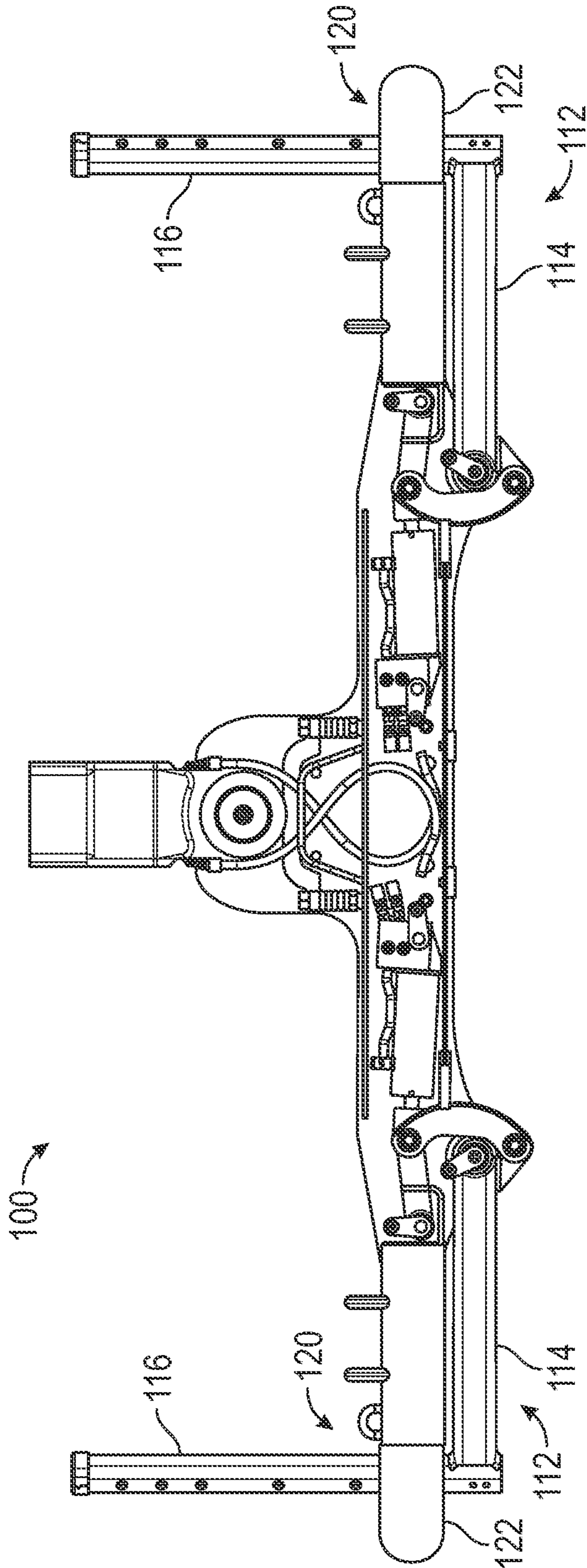


FIG. 10

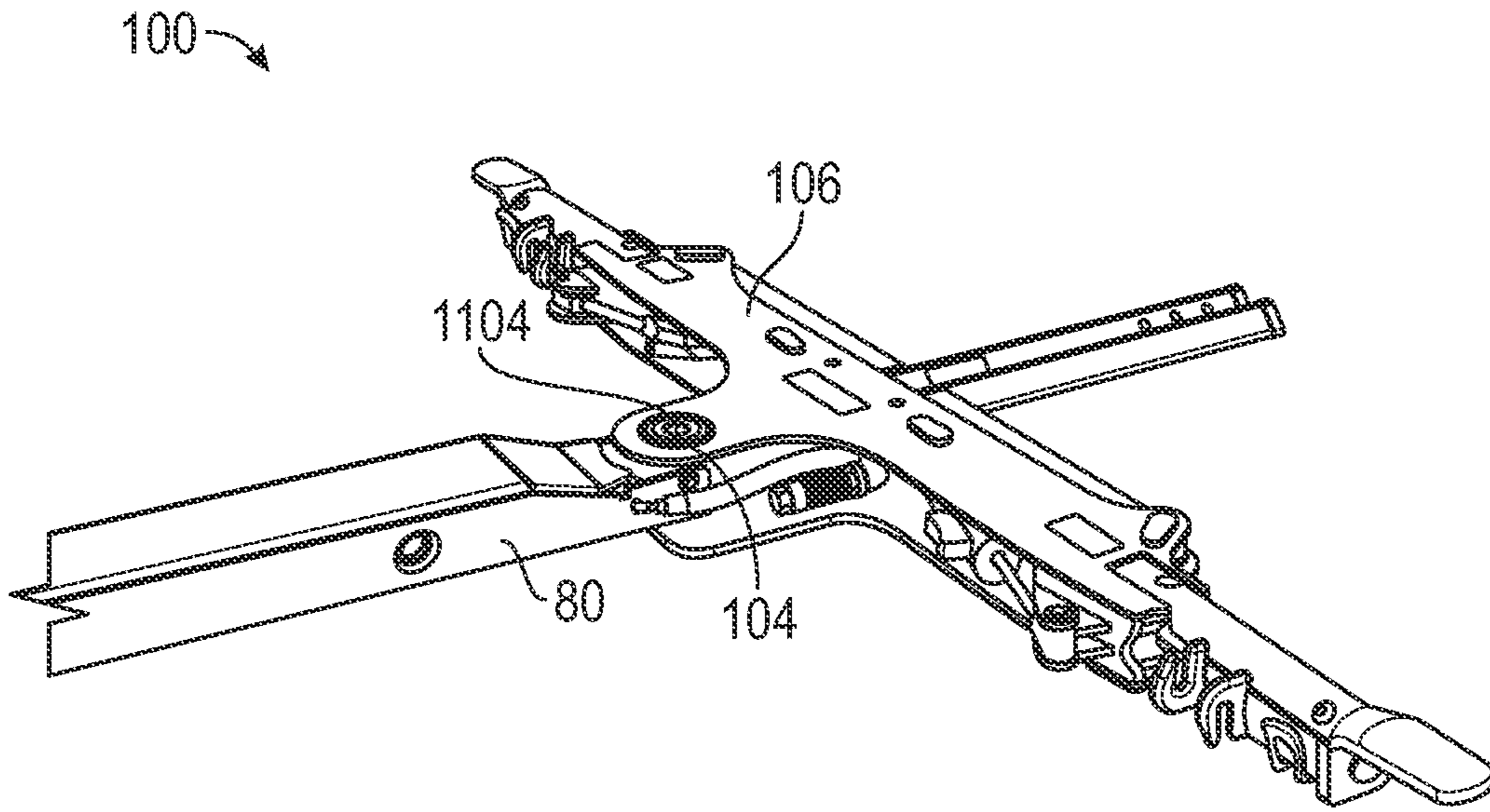


FIG. 11A

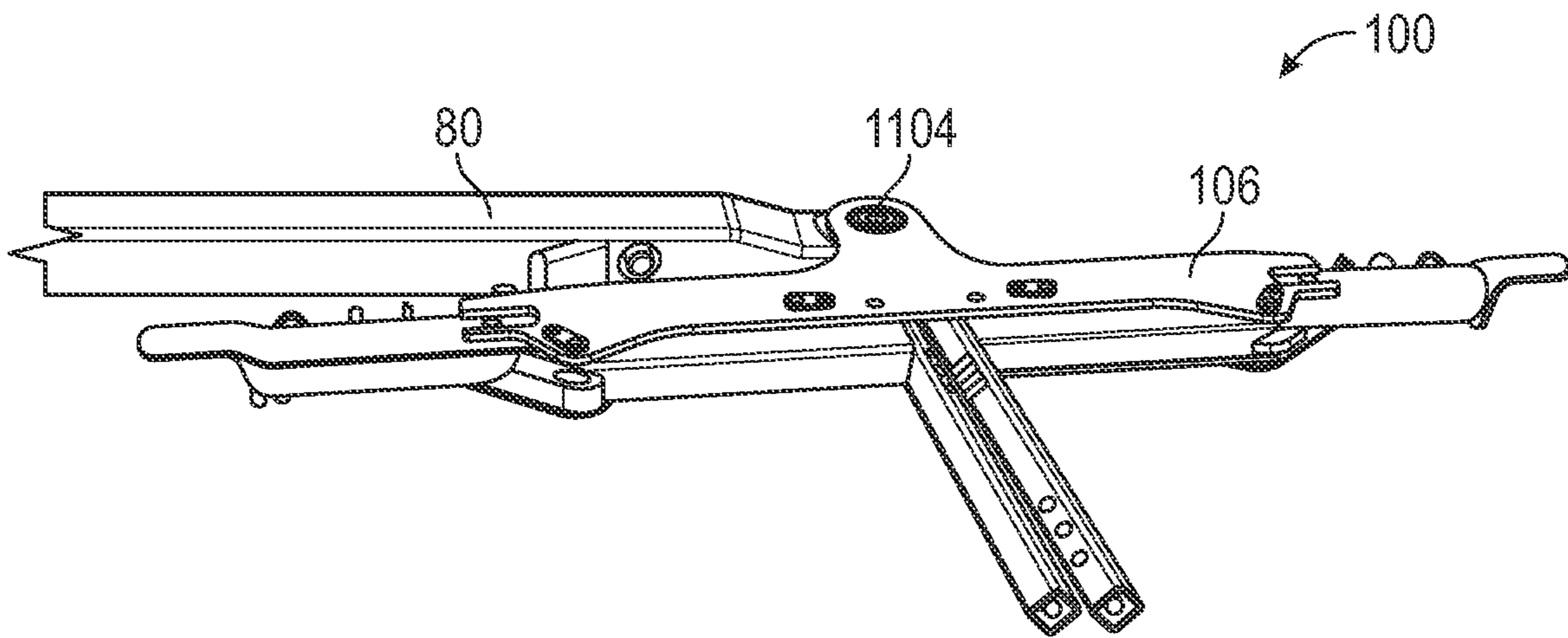


FIG. 11B

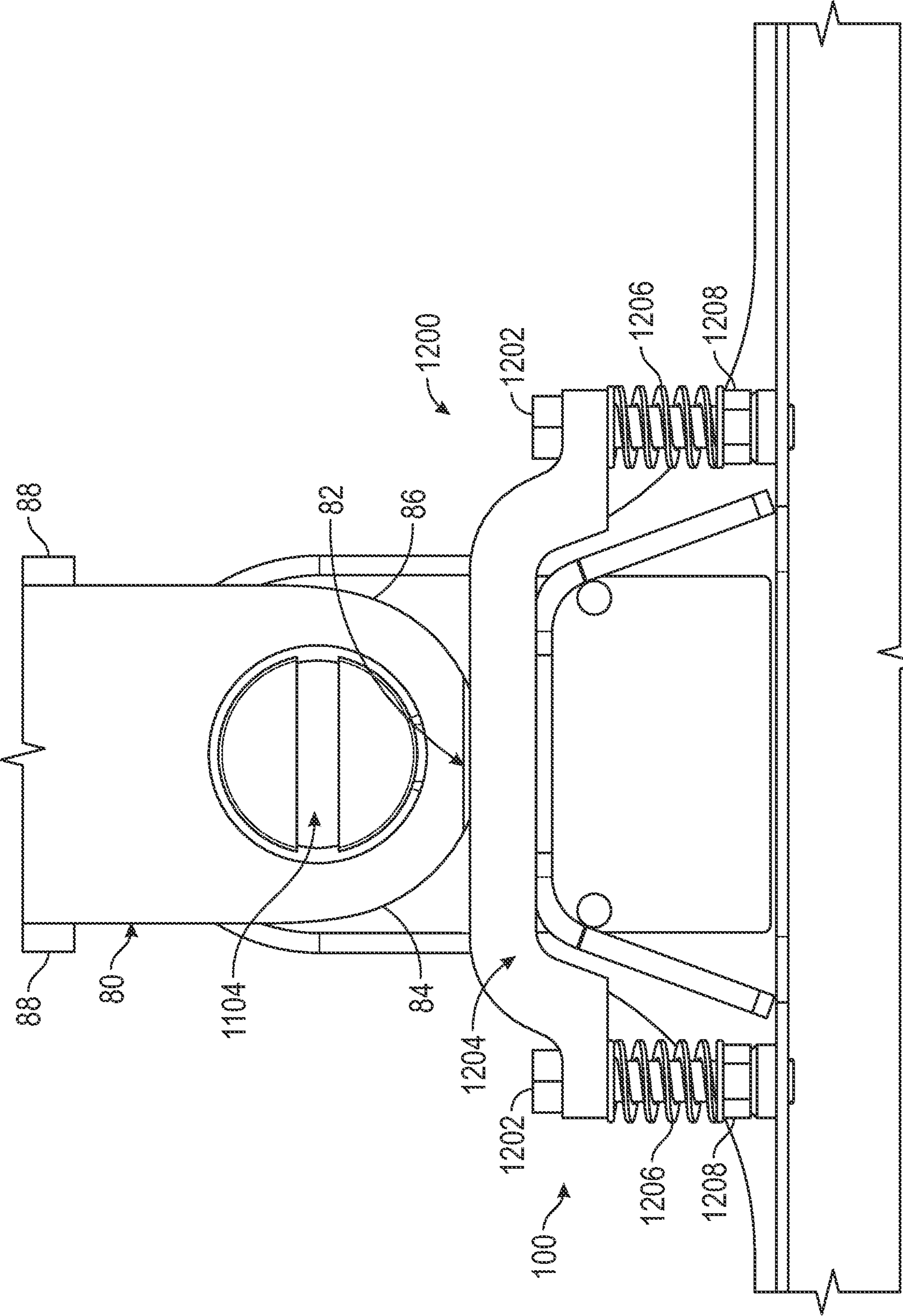


FIG. 12

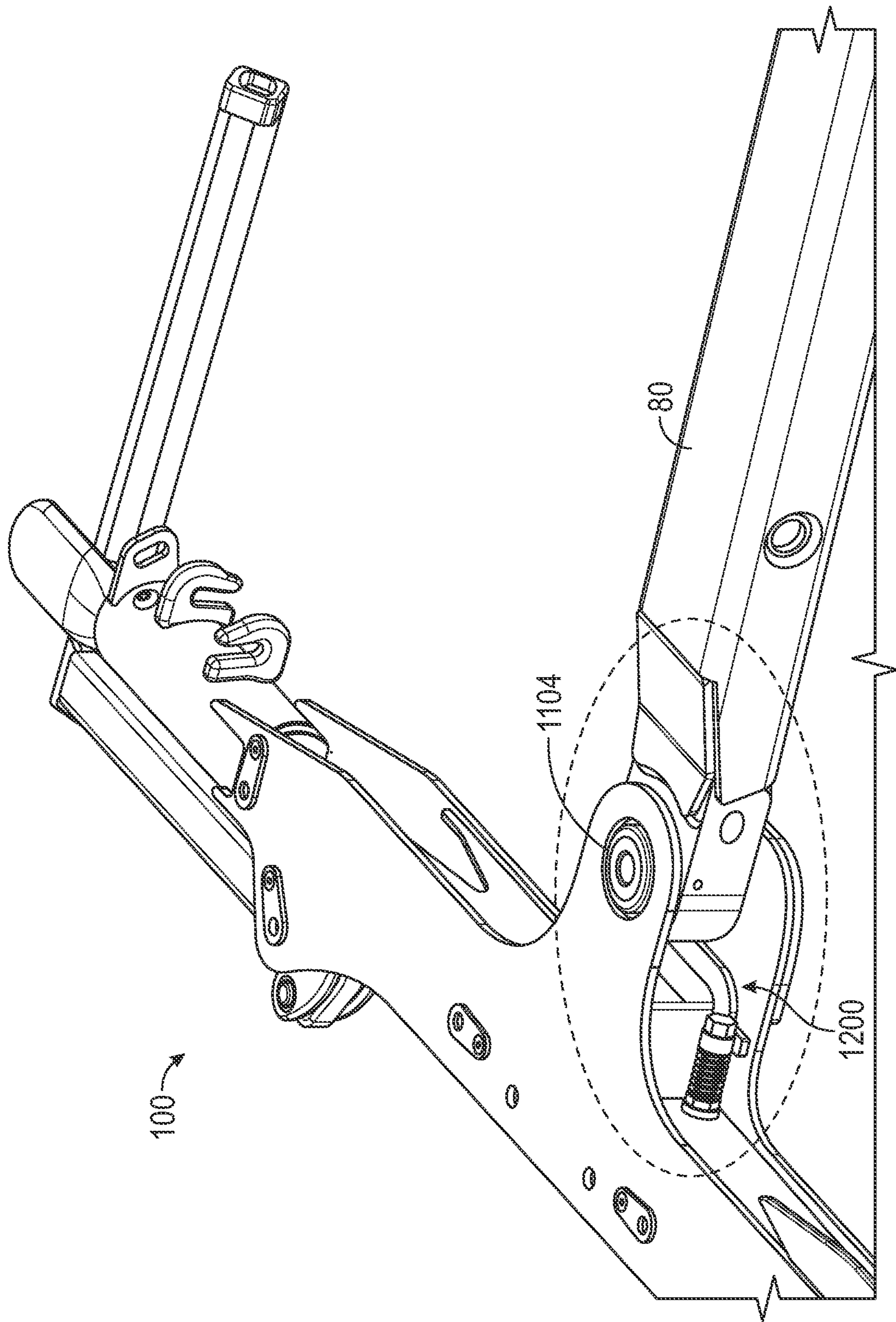


FIG. 13

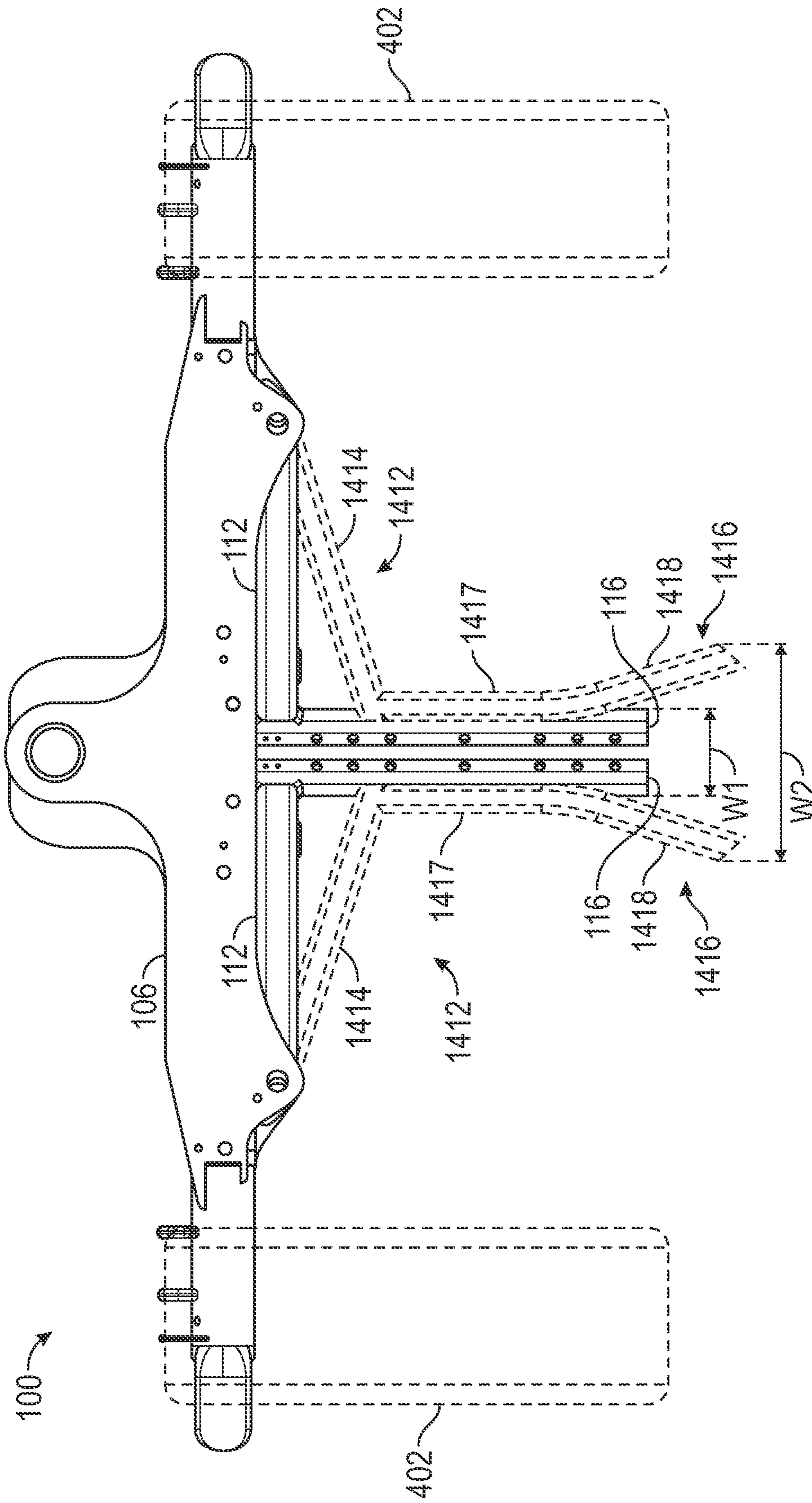


FIG. 14

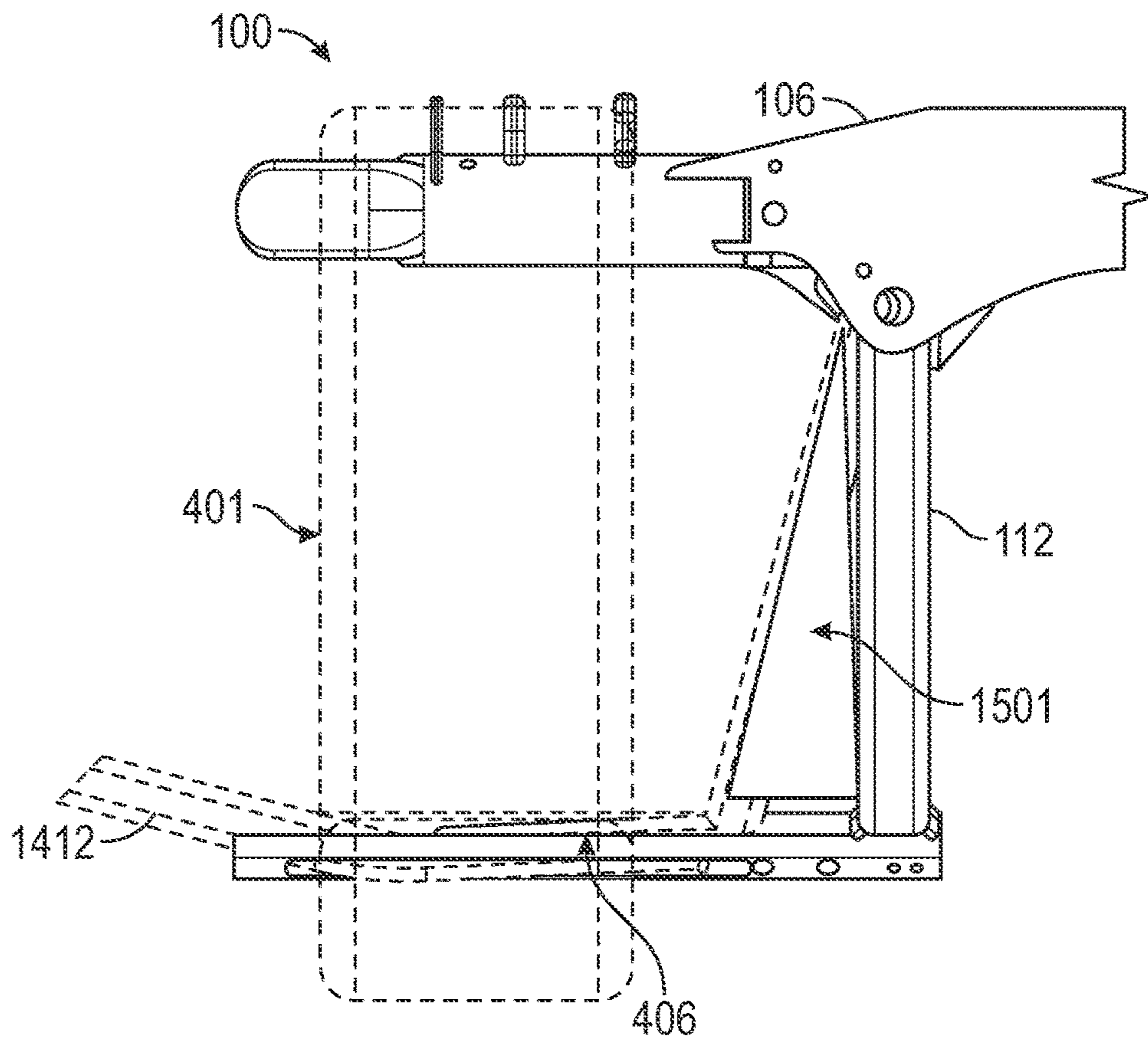


FIG. 15

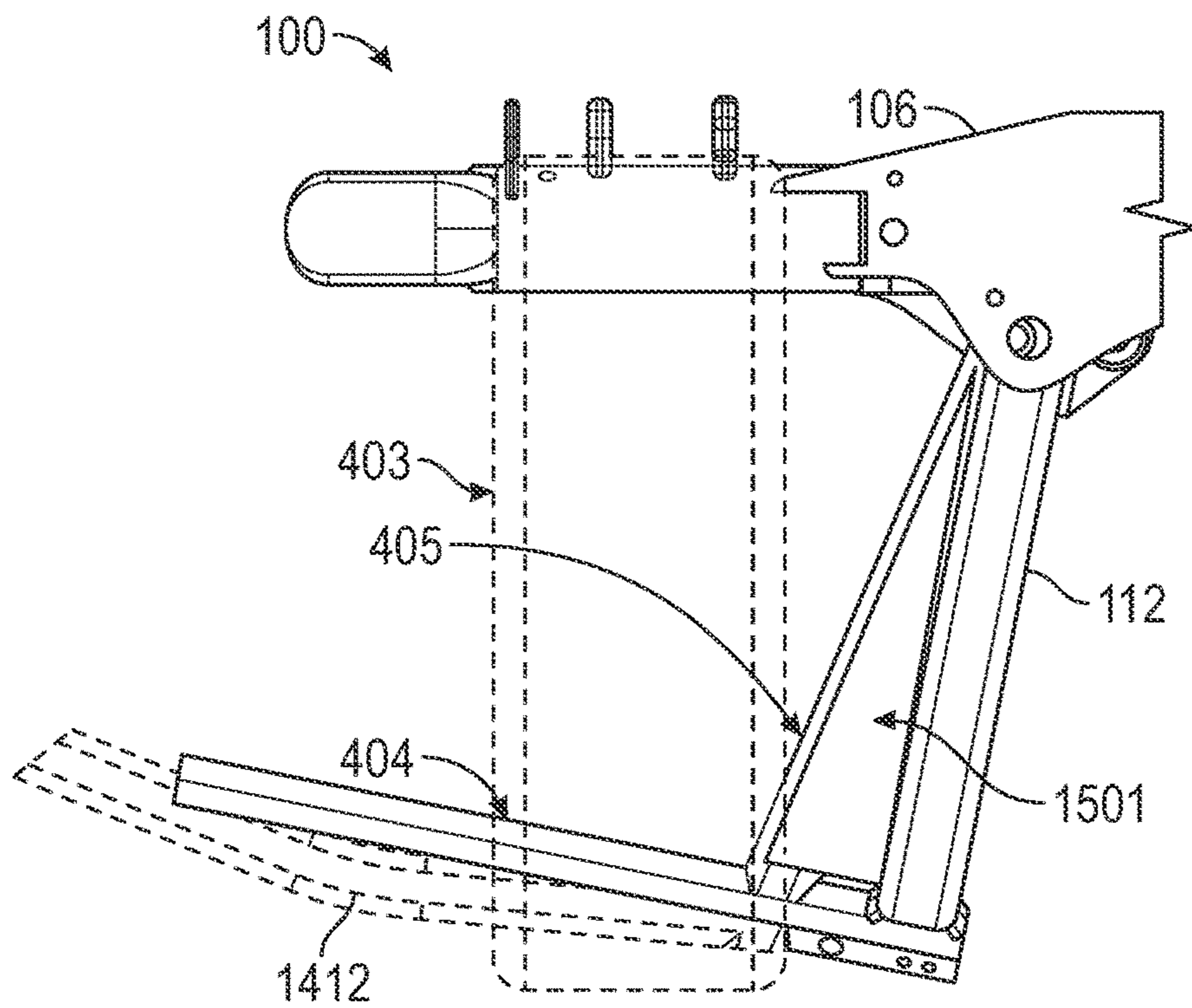


FIG. 16



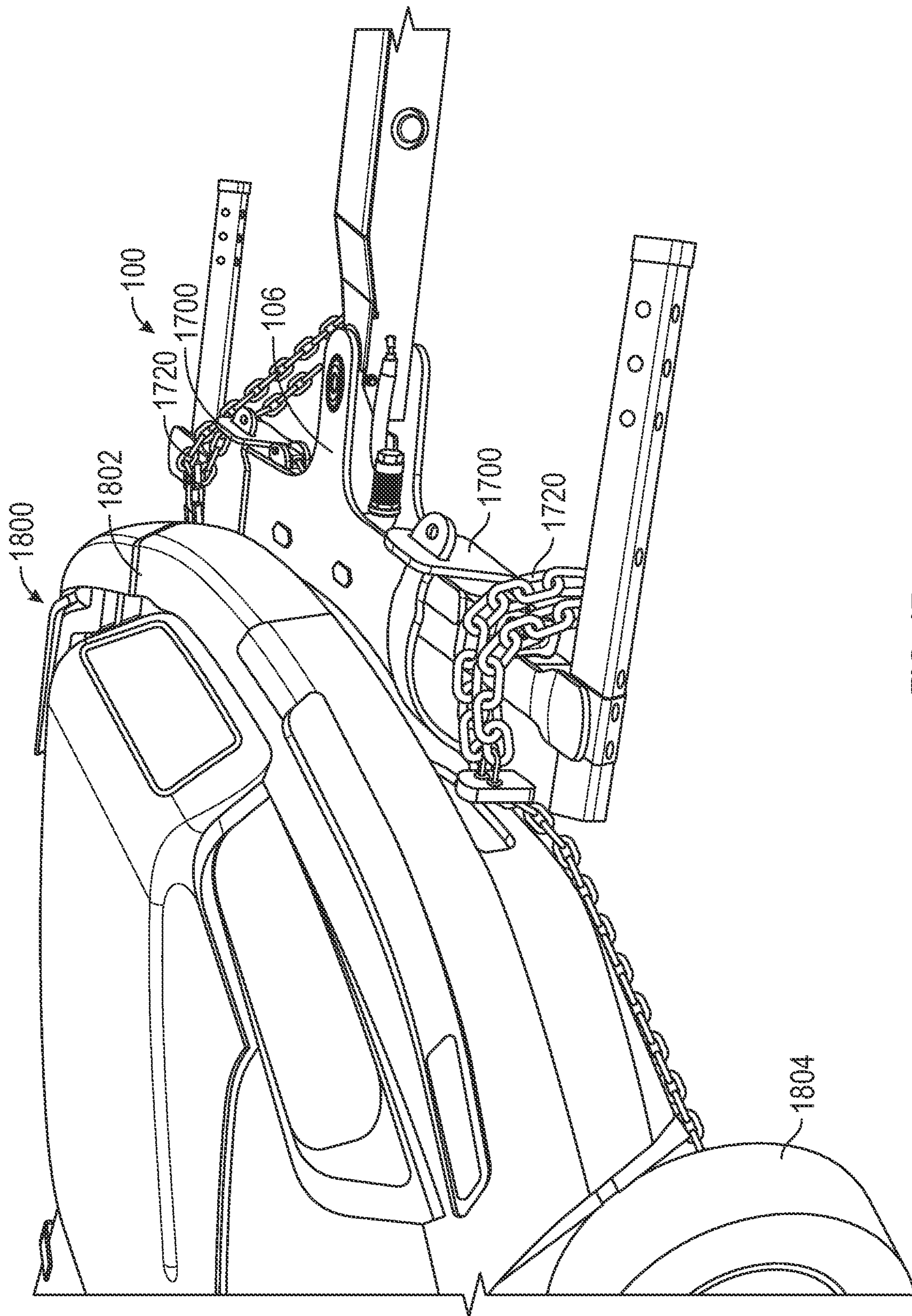


FIG. 17

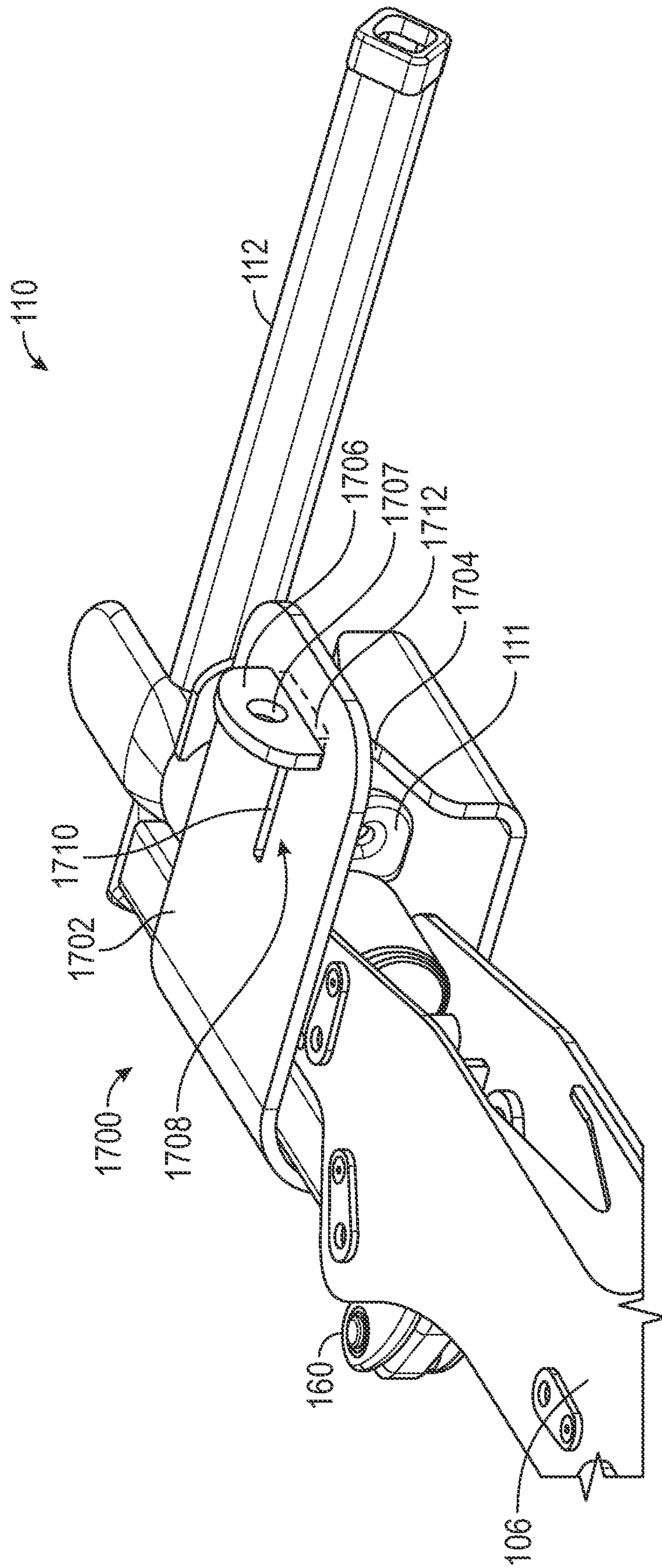


FIG. 18

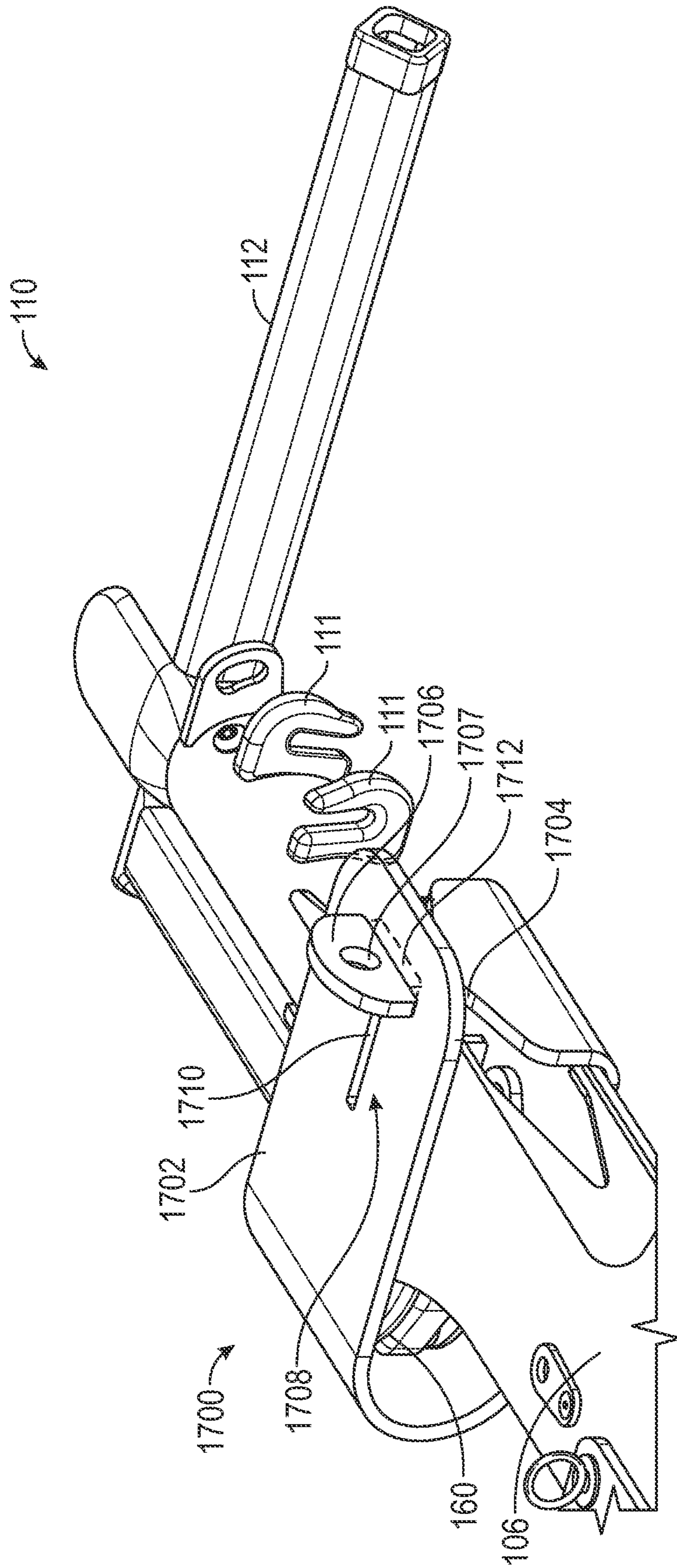


FIG. 19

## 1

## AUTOMATIC WHEEL GRID

## BACKGROUND

The present disclosure relates generally to vehicle towing. More specifically, the present disclosure relates to an automatic wheel grid capable of supporting a wide range of track widths and tire sizes.

## SUMMARY

One embodiment relates to a wheel grid including a crossbar, a first L-arm, a second L-arm, a first crossbar end, and a second crossbar end. The crossbar is configured to be coupled to a main boom of a wheel lift tow vehicle. The first L-arm is rotatably coupled to the crossbar at a first pivot point and includes a first extension member and a first wheel brace member. The second L-arm is rotatably coupled to the crossbar at a second pivot point and includes a second extension member and a second wheel brace member. The first crossbar end is coupled to a first end of the crossbar and is configured to engage a first tire of a towed vehicle. The first crossbar end includes a first cantilevered portion. The second crossbar end is coupled to a second end of the crossbar and is configured to engage a second tire of the towed vehicle. The second crossbar end includes a second cantilevered portion. The first and second L-arms are configured to rotate into a stowed position in which the first wheel brace member is positioned under the first cantilevered portion and the second wheel brace member is positioned under the second cantilevered portion.

Another embodiment relates to a tow vehicle including a tow vehicle frame, a main boom coupled to the tow vehicle frame and extending rearward from the tow vehicle frame, and a wheel grid rotatably coupled to the main boom by a rotation pin. The wheel grid includes a crossbar configured to be coupled to the main boom, an L-arm rotatably coupled to the crossbar at a pivot point, the L-arm comprising an extension member and a wheel brace member, and a crossbar end coupled to an end of the crossbar and configured to engage a tire of a towed vehicle, the crossbar end comprising a cantilevered portion. The L-arm is configured to rotate into a stowed position in which the wheel brace member is positioned under the cantilevered portion.

Another embodiment relates to a tow vehicle including a tow vehicle frame, a main boom coupled to the tow vehicle frame and extending rearward from the tow vehicle frame, and a wheel grid rotatably coupled to the main boom by a rotation pin. The wheel grid is positionable in a neutral position in which a crossbar of the wheel grid is perpendicular to the main boom and rotatable at least 90 degrees clockwise and 90 degrees counterclockwise from the neutral position about the rotation pin.

This summary is illustrative only and is not intended to be in any way limiting. Other aspects, inventive features, and advantages of the devices or processes described herein will become apparent in the detailed description set forth herein, taken in conjunction with the accompanying figures, wherein like reference numerals refer to like elements.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a wheel grid, according to an exemplary embodiment.

FIG. 2 is a perspective view the wheel grid of FIG. 1.

FIGS. 3A and 3B are side view diagrams of a tire being engaged by a wheel grid.

## 2

FIG. 4 is a perspective view the wheel grid of FIG. 1 engaging a tire.

FIG. 5 is a plan view of the wheel grid of FIG. 1 in a loading position.

FIG. 6 is a plan view of the wheel grid of FIG. 1 transitioning from a loading position to an engaged position.

FIG. 7 is a plan view of the wheel grid of FIG. 1 in an engaged position.

FIG. 8 is a plan view of the wheel grid of FIG. 1 in an over-rotated engaged position.

FIG. 9 is a plan view of the wheel grid of FIG. 1 transitioning from an engaged position to a stowed position.

FIG. 10 is a plan view of the wheel grid of FIG. 1 in a stowed position.

FIGS. 11A and 11B are perspective views of the wheel grid of FIG. 1.

FIG. 12 is a plan view of an interface between a main boom and the wheel grid of FIG. 1, according to an exemplary embodiment.

FIG. 13 is a perspective view of the interface of FIG. 12.

FIGS. 14-16 are plan views of the wheel grid of FIG. 1 with overlaid alternative shaped L-arms.

FIG. 17 is a perspective view of the wheel grid of FIG. 1 lifting a vehicle with chains, including protective belts positioned between the vehicle bumper and the wheel grid, according to an exemplary embodiment.

FIGS. 18 and 19 are perspective views of the wheel grid of FIG. 1, including one of the protective belts of FIG. 17.

## DETAILED DESCRIPTION

Before turning to the figures, which illustrate certain exemplary embodiments in detail, it should be understood that the present disclosure is not limited to the details or methodology set forth in the description or illustrated in the figures. It should also be understood that the terminology used herein is for the purpose of description only and should not be regarded as limiting.

A wheel grid is a device that can be mounted to a tow vehicle to enable towing of another vehicle. The wheel grid is configured to lift the front or rear wheels of the towed vehicle off the ground by engaging the respective front or rear tires of the towed vehicle. This is generally preferable to using a hook to engage the frame of the vehicle, which may cause damage to the towed vehicle or may be more difficult due to the design of the towed vehicle. For the purpose of brevity, the remainder of the present disclosure will discuss wheel grids engaging with the front tires of towed vehicles. However, it should be understood that the embodiments disclosed herein may be used to tow a vehicle by lifting the rear wheels instead.

A wheel grid is generally mounted to a main boom coupled to and extending out from the rear of the tow vehicle. The wheel grid includes a main crossbar, which is generally fixed in position and engages the front sides of the front tires. The wheel grid may include two L-arms configured to rotate from a loading position, in which the L-arms can be inserted between the front wheels of the towed vehicle, to an engaged position, in which the L-arms engage the rear sides of the front tires. The boom then lifts the wheel grid, and the front tires of the towed vehicle are lifted off the ground by the crossbar and the L-arms. Some wheel grids are designed such that the L-arms can rotate into a third, stowed position when no vehicle is being towed. In the stowed position, the L-arms are tucked underneath the tow vehicle so they do not extend beyond the rear of the tow vehicle, creating a potential safety hazard.

An additional concern when designing wheel grids is the wide range of track widths (e.g., the distance between the two front tires) and tire sizes of various vehicles that may need to be towed. For example, compact sedans generally have narrower track widths and tire sizes than full-size pickup trucks. It is advantageous that a wheel grid is able to be used to tow a wide variety of vehicle types.

According to an exemplary embodiment, a wheel grid includes a crossbar configured to be coupled to a main boom of a wheel lift tow vehicle; two L-arms, each coupled to the crossbar at a respective pivot point and including an extension member and a wheel brace member; and a crossbar end coupled to each end of the crossbar and including a cantilevered portion, the crossbar ends each configured to engage a tire of a towed vehicle. The L-arms are configured to rotate into a stowed position in which each L arm is positioned under one of the cantilevered portions.

Referring now to FIGS. 1 and 2, a wheel grid 100 is shown, according to some embodiments. The wheel grid 100 includes a mounting bracket 102 including an opening 104. The opening 104 is configured to receive a pin such that the mounting bracket 102 can be rotatably coupled to a main boom of a tow truck by the pin. The mounting bracket 102 is coupled to a crossbar 106 that extends from a left end 108 to a right end 110. The wheel grid 100 includes two L-arms 112 for engaging the front tires of a towed vehicle. Each L-arm 112 includes an extension member 114 coupled to a wheel brace member 116. The wheel brace member 116 may be substantially straight and substantially perpendicular to the extension member 114. The L-arms 112 are rotatably coupled to the crossbar 106 at rotation points 118 (e.g., pivot points, etc.). Specifically, a proximal end of the extension member 114 is coupled to the rotation point 118 and a distal end of the extension member 114 is coupled to a proximal end of the wheel brace member 116. In FIG. 1, the wheel grid 100 is shown in an engaged position, in which the wheel grid 100 may be engaged with the tires of a towed vehicle. The crossbar 106 engages the front of the front tires of the towed vehicle, the extension members 114 extend rearward between the front tires, and the wheel brace members 116 engage the rear of the front tires. The distance from the left end 108 to the right end 110 is shown as width W. The distance from the crossbar 106 to the wheel brace members 116 is shown as distance D2.

FIG. 2 shows the wheel grid 100 in a stowed position, in which the L-arms 112 rotate approximately 90 degrees from the engaged position such that the extension members 114 are substantially parallel and adjacent to the crossbar 106 and the wheel brace members 116 extend forward underneath the tow vehicle in a direction substantially perpendicular to the crossbar 106. In conventional wheel grids, the distance from the rotation point 118 to the wheel brace member 116, shown as distance D3, may be greater than the distance from the rotation point 118 to the end 108 of the crossbar 106, shown as distance D1. In these conventional wheel grids, when the L-arms 112 rotate into the stowed position, the wheel brace members 116 may be positioned further from the center of the wheel grid 100 than the end 108 of the crossbar 106. This allows the L-arms 112 to rotate into the stowed position without the crossbar 106 interfering. However, in order to tow a wide range of vehicles, it may be advantageous to reduce the distance D2 so that the wheel grid can be used to tow vehicles with smaller tires. It is also advantageous to increase the distance D1, and more specifically, the width W of the crossbar 106, so that vehicles with wider track widths can also be towed. In order to increase the width W while decreasing the distance D1

(thereby reducing the distance D3), the wheel grid 100 includes a crossbar end 120 at either end of the crossbar 106. The crossbar end 120 includes a cantilevered portion 122 that allows the wheel brace members 116 to rotate under the ends 108, 110 of the crossbar 106. Thus, according to some embodiments, the wheel grid 100 has a distance D3 from the rotation point 118 to the wheel brace member 116 that is shorter than the distance D1 from the rotation point 118 to the end 108 of the crossbar 106.

Referring now to FIGS. 3A and 3B, partial cross section views of two wheel grids 300a, 300b are shown engaging a towed vehicle 301, according to some embodiments. The wheel grid 300a includes a crossbar 306a that is a distance D4 away from a wheel brace member 308a. The wheel grid 300b includes a crossbar 306b that is a distance D5 away from a wheel brace member 308b. Distance D5 is greater than distance D4. When wheel grid 300a engages the tire 302 of the towed vehicle 300, the tire 302 sits high enough that there is clearance between the crossbar 306a and the oil pan 304 and other components of the undercarriage of the towed vehicle 301. However, because the distance D5 between the crossbar 306b and the wheel brace member 308b of the wheel grid 300b is larger, the tire 302 sits lower on the wheel grid 300b and the crossbar 306b may contact and damage the oil pan 304 and other components of the undercarriage of the towed vehicle 301. FIG. 4 shows a wheel grid 100 with an L-arm 112 that is over-rotated such that the wheel brace member 116 contacts the tire 402 of a towed vehicle at a contact point 404 near the outside of the tire 402. It should be understood that "over-rotated" refers to the rotation of the L-arm 112 such that the extension member 114 and the crossbar 106 form an angle greater than 90 degrees. The contact point 404 is a distance D6 from the crossbar 106, which is shorter than the length of the extension member 114 due to the over-rotation of the L-arm 112. This may be necessary to tow vehicles with smaller tires 402. The longer the extension member 114, the more the L-arm 112 must over-rotate to contact the tire 402 at an acceptable distance D6. If the extension member 114 is too long, the wheel brace member 116 may contact the tire 402 at a contact point 404 that is too close to the sidewall of the tire 402 or the extension member 114 may contact the sidewall of the tire 402, either of which can damage the tire 402.

FIGS. 5-11 illustrate the wheel grid 100 with the L-arms 112 rotated into various operational positions, according to some embodiments. The wheel grid 100 is coupled to a boom 80, which may be coupled to and extend rearward from a tow vehicle. FIG. 5 shows the wheel grid 100 in the loading position, with the wheel brace members 116 perpendicular to the crossbar 106 and extending rearward and the extension members 114 parallel and adjacent to the crossbar 106. To engage a vehicle to be towed, the tow vehicle backs up towards the towed vehicle and the wheel brace members 116 are inserted between the front wheels of the towed vehicle until the crossbar 106 contacts the towed vehicle. Linear actuators 150 are configured to rotate the L-arms 112 to move them between the loading, engaged, and stowed positions. FIG. 6 shows the wheel grid 100 with the L-arms 112 in transition between the loading position and the engaged position. The rods 152 of the linear actuators 150 retract into the cylinders 154, rotating the linkages 160 causing the L-arms 112 to rotate. The linear actuators 150 may be, for example, electromechanical actuators, pneumatic actuators, or hydraulic actuators that may be controlled via user input. In some embodiments, other actuators or configurations may be used to cause the rotation of the

L-arms **112**. The arrangement of the linkages **160** allows the linear actuators **150** to be substantially within the footprint of the crossbar **106** and enable at least 180-degree rotation of the L-arms **112** from the stowed position to the loading position. This, combined with the positioning of the rotation points **118**, allows the extension members **114** to be substantially parallel and directly adjacent to the crossbar **106** when in the loading position. When in the loading position, the wheel brace member **116** may be substantially parallel and directly adjacent to one another. This may allow the wheel brace members **116** to more easily fit between the tires of the towed vehicle, particularly when the towed vehicle must be engaged by the wheel grid **100** at an angle.

FIG. **7** shows the wheel grid **100** with the L-arms **112** rotated into an engaged position such that the wheel brace members **116** are roughly parallel to the crossbar **106**. The wheel brace members **116** may engage the rear side of the front tires of the towed vehicle. The boom **80** can then lift the wheel grid **100** causing the crossbar **106** and the wheel brace members **116** to lift the front of the towed vehicle by engaging the front tires. It should be understood that one or more of the crossbar **106** or the wheel brace members **116** may not contact the tire until the wheel grid **100** is partially lifted. FIG. **8** shows the wheel grid **100** in an over-rotated engaged position. As discussed above, for towing vehicles with smaller tires, a small amount of over-rotation may be necessary to reduce the distance **D6** from the crossbar **106** to the contact point **404** of the tire on the wheel brace member **116**. FIG. **9** shows the wheel grid **100** with the L-arms **112** in transition between an engaged position and a stowed position. The rods **152** of the linear actuators **150** continue to retract into the cylinders **154**, rotating the linkages **160** causing the L-arms **112** to rotate further.

FIG. **10** shows the wheel grid **100** with the L-arms **112** in a stowed position such that the extension members **114** are adjacent the crossbar **106** and the wheel brace members **116** extend forward toward the tow vehicle. The wheel brace members **116** pass under the cantilevered portions **122** of the crossbar ends **120**. As discussed above, this allows the distance **D3** from the crossbar **106** to the wheel brace members **116** to be reduced while maintaining the width **W** of the crossbar **106**. Because the wheel brace members **116** pass under the cantilevered portions **122** of the crossbar ends **120**, the crossbar **106** does not interfere with the rotation of the L-arms **112** into the stowed position.

FIGS. **11A** and **11B** show the wheel grid **100** rotated zero degrees and ninety degrees, respectively, about a rotation pin **1104** inserted into the opening **104** in the mounting bracket **102**, according to some embodiments. The rotation pin **1104** rotatable couples the wheel grid **100** to the main boom **80** to allow the tow vehicle to engage the tires of a towed vehicle from an angle. For example, it may not be possible to load a car parallel parked between two other cars with the crossbar **106** in a static position perpendicular to the main boom **80**. Rotation of the wheel grid **100** allows the towed car to be engaged and pulled out of the parking spot at an angle. In some embodiments, the wheel grid **100** may be inserted under the center of a parallel-parked vehicle from the side, and the crossbar **106** may engage the rear of the front tires while the wheel brace members **116** engage the front of the front tires. The towed vehicle can be pulled out of the parking spot, set back down, and reengaged from the front to be towed away. In some embodiments, the rotation of the wheel grid **100** relative to the main boom **80** may be actuated (e.g., electrically, hydraulically, or pneumatically actuated). In some embodiments, the wheel grid **100** rotates when it comes in contact with a tire of a towed vehicle. The

tire pushes the wheel grid **100** left or right causing the rotation as the tow vehicle backs toward the towed vehicle. The wheel grid **100** may be able to rotate at least 90 degrees in either direction (clockwise or counterclockwise) from the neutral position in which the crossbar **106** is perpendicular to the main boom **80**.

FIG. **12** shows a detent assembly **1200** that resists the rotation of the wheel grid **100** relative to the main boom **80**, according to some embodiments. The detent assembly **1201** may be mounted to the crossbar **106** by two fasteners **1202** (e.g., threaded fasteners, screws, shoulder screws, etc.). The fasteners **1202** each extend through a respective clearance hole in a detent bracket **1204**, such that the detent bracket **1204** is slidably coupled (e.g., not threadedly coupled) to the fasteners **1202**. A spring **1206** is positioned around each of the fasteners **1202** and biases the detent bracket **1204** toward the main boom **80**. The fasteners **1202** may be threadedly coupled to the crossbar **106**, and a locknut **1208** may be threadedly coupled to each fastener **1202** to hold the fastener **1202** in position relative to the crossbar **106**. When the wheel grid **100** is in the neutral position (e.g., when the crossbar **106** is perpendicular to the main boom **80**), the springs **1206** bias the detent bracket **1204** such that the detent bracket **1204** engages a detent flat **82** in the main boom **80**. This configuration resists the rotation of the wheel grid **100** until a rotational force on the wheel grid **100** overcomes the force of the detent assembly **1100**. The towed vehicle may thus be kept substantially in line with the tow vehicle unless a relatively strong rotational force overcomes the force of the detent assembly **1100**. The detent assembly **1201** may also prevent or resist the rotation of the wheel grid **100** when the wheel grid **100** is in the stowed position to stop the wheel grid **100** from swinging and potentially contacting the rear wheels or other components of the tow vehicle. The main boom **80** includes a left portion **84** and a right portion **86**, each with a circular profile, which the detent bracket **1204** contacts when the wheel grid **100** is rotated out of the neutral position. FIG. **13** shows a perspective view of the detent assembly **1200**.

In some embodiments, the main boom **80** may include stops **88** to limit the overall rotation of the wheel grid **100** in either direction. The stops **88** may be positioned such that the heads of the fasteners **1202** contact the stops. Fine control of the maximum amount of rotation of the wheel grid **100** can be achieved by adjusting the extension of the fasteners **1202** away from the crossbar **106**. For example, the fasteners **1202** can be loosened such that the heads of the fasteners **1202** are farther from the crossbar **106**. The heads of the fasteners **1202** will then contact the stops **88** on the main boom **80** at a lower amount of rotation. Conversely, the fasteners **1202** can be tightened such that the heads of the fasteners **1202** are closer to the crossbar **106**, and the wheel grid **100** will be able to rotate further before the fasteners **1202** contact the stops **88**.

FIGS. **14-16** show the wheel grid **100** with overlaid alternatively shaped L-arms **1412**, to emphasize the advantages of the shape of the L-arms **112**. The L-arms **1412** are designed with extension members **1414** that are not able to rotate into a parallel and adjacent position relative to the crossbar **106**. The L-arms **1412** may also include wheel brace members **1416** that have a straight portion **1417** and an angled end **1418**. The angled ends **1418** cause the combined width **W2** of the wheel brace members **1416** in the loading position to be larger than the width **W1** is the combined wheel brace members **116** in the loading position. This makes it more difficult to fit the wheel brace member **1416** between the tires of the towed vehicle. FIGS. **15** and **16**

show the wheel grid **100** and the alternatively shaped L-arms **1412** in a loading position engaging a large tire **401** and an over-rotated loading position engaging a small tire **403**, respectively. As shown in FIG. **15**, because the straight portion **1417** of the wheel brace member **1416** is not perpendicular to the extension member **1414**, an area **1501** of interference is created. When engaging a towed vehicle with large tires **401**, the area **1501** requires that the wheel grid is more centered on the towed vehicle. If the wheel grid is not centered, the straight portion **1417** of the wheel brace member **1416** can contact the sidewall of the tire **401**. As shown in FIG. **16**, when towing a vehicle with small tires **403**, the straight portion **1417** of the wheel brace member **1416** may contact the sidewall of the tire **403** at a contact point **405** rather than making contact at the back of the tire at contact point **404**. To avoid contact at the contact point **405**, the L-arms **1412** cannot over-rotate as much as the L-arms **112**, which causes a towed vehicle with small tires **403** to drop lower into the wheel grid, potentially causing contact between the wheel grid and the undercarriage of the towed vehicle. Thus, in the case of a small tire **403** or a large tire **401**, the L-arms **112** provide advantages over the alternatively designed L-arms **1412**.

#### Crossbar Belting

In certain situations, it may be difficult or impossible to tow a vehicle by engaging the tires with a wheel grid (e.g., wheel grid **100**). For example, if the tires of the towed vehicle are damaged or the wheels or tires are removed, the crossbar and L-arms may not be able to properly engage and lift the vehicle. Instead, one or more chains coupled to the crossbar may be used to lift the vehicle. The tow vehicle may back toward the towed vehicle until the crossbar is approximately aligned with the front bumper of the towed vehicle. Then, a chain may be coupled to a hook on one side of the crossbar, coupled to the axle of the towed vehicle, and then coupled to a hook on the other side of the crossbar. Alternatively, a separate chain may be coupled to each side of the crossbar and the axle. When the wheel grid is lifted, the chains lift the vehicle and the crossbar contacts or nearly contacts the front bumper. In this towing arrangement, the crossbar may cause damage to the bumper if there is no protection in place between the bumper and the crossbar, which is generally made of metal, such as steel or aluminum.

Referring now to FIGS. **17-19**, the wheel grid **100** is shown with a protective belt **1700**, according to some embodiments. The belt **1700** is positioned around the crossbar **106** and provides a barrier between the crossbar **106** and the bumper **1802** of the towed vehicle **1800**. The belt **1700** may be made of a flexible, relatively soft material that may reduce scratches, dents, and other damage to the bumper **1802** that may occur if the bumper **1802** directly contacted the crossbar **106**. For example, the belt **1700** may be made from a rubber, plastic, or composite material. The material may also be selected to provide a non-slip surface so that the bumper **1802** does not slide across the crossbar **106**, which may further reduce the damage to the bumper. The belt **1700** may also protect the wheel grid **100** itself. For example, as shown in FIG. **19**, the belt may be positioned around the L-arm actuator linkages **160**, protecting the linkages **160** as well as the crossbar **106** itself from damage caused by lifting the bumper **1802**.

When a vehicle **1800** requires a chain lift (e.g., due to damage to the tires **1804**), the L-arms **112** are rotated into the stowed position, as shown in FIGS. **17-19**. A belt **1700** is then installed on each side of the crossbar **106**. The belt **1700** includes an elongated body **1702** long enough to wrap around the crossbar **106**. The belt **1700** further includes a

narrow portion **1704** that widens to a tab **1706** at one end of the belt **1700**. At the other end of the belt **1700** is a slot **1708** sized to receive and retain the tab **1706**. The slot **1708** may be, for example, a T-shaped slot with a vertical portion **1710** and a horizontal portion **1712**. To install the belt **1700** on the crossbar **106**, the belt **1700** is first positioned around the chain hooks **111** near an outer end of the crossbar **106**, as shown in FIG. **18**. In this area, the crossbar **106** may be relatively narrow, allowing for more room to install belt **1700**. Next, the tab **1706** is inserted into the vertical portion **1710** of the slot **1708** by turning the tab end of the belt **1700** ninety degrees from its natural position. Because of the shape and flexible material of the belt **1700**, a user may rotate the tab **1706** by hand. Once the tab **1706** has been fully inserted, the tab may be rotated ninety degrees back to its natural position, and the narrow portion **1704** may be moved into the horizontal portion **1712** of the slot **1708**. Because the tab **1706** is wider than the horizontal portion **1712** of the slot **1708**, the tab **1706** cannot be pulled through the horizontal portion **1712**, and the belt **1700** is retained around the crossbar **106**. Finally, the belt **1700** can be slid toward the center of the crossbar **106** into an installed position around the linkages **160**, as shown in FIG. **19**. Because the crossbar **106** is wider in this position, the belt **1700** may fit snugly around the crossbar and be held in place by friction. A second belt **1700** may be installed on the other end of the crossbar **106**.

Once the belts **1700** are in the installed position, the tow vehicle can back the wheel grid **100** up to a towed vehicle until the crossbar is roughly aligned with the bumper. Then, a user can install the chain **1720** by coupling a first end of the chain **1720** to the hooks **111** on a first side of the crossbar **106**, coupling the chain **1720** to the axle or other structural component of the towed vehicle, and coupling the other side of the chain **1720** to hooks **111** on the other side of the crossbar **106**. In some embodiments, separate chains **1720** may be used on each side of the crossbar **106**. Once the chains **1720** are installed, the wheel grid **100** can be lifted, causing the chains to lift the vehicle **1800**. As shown in FIG. **17**, the belts separate the bumper **1802** of the towed vehicle **1800** from the wheel grid, protecting the bumper **1802**, the crossbar **106**, and the linkages **160** from damage. To remove the belt **1700**, the process is reversed. The vehicle is lowered to the ground and the chains **1720** are removed. The belts **1700** are slid toward the end of the crossbar, and the tab **1706** is turned ninety degrees and pulled back through the vertical portion **1710** of the slot **1708**. The tab **1706** may include an opening **1707** that can be used to pull the tab **1706** when installing or removing the belt **1700** or can be used to hook the belt **1700** in a storage location.

As utilized herein, the terms “approximately,” “about,” “substantially,” and similar terms are intended to have a broad meaning in harmony with the common and accepted usage by those of ordinary skill in the art to which the subject matter of this disclosure pertains. It should be understood by those of skill in the art who review this disclosure that these terms are intended to allow a description of certain features described and claimed without restricting the scope of these features to the precise numerical ranges provided. Accordingly, these terms should be interpreted as indicating that insubstantial or inconsequential modifications or alterations of the subject matter described and claimed are considered to be within the scope of the disclosure as recited in the appended claims.

It should be noted that the term “exemplary” and variations thereof, as used herein to describe various embodiments, are intended to indicate that such embodiments are

possible examples, representations, or illustrations of possible embodiments (and such terms are not intended to connote that such embodiments are necessarily extraordinary or superlative examples).

The term “coupled” and variations thereof, as used herein, means the joining of two members directly or indirectly to one another. Such joining may be stationary (e.g., permanent or fixed) or moveable (e.g., removable or releasable). Such joining may be achieved with the two members coupled directly to each other, with the two members coupled to each other using a separate intervening member and any additional intermediate members coupled with one another, or with the two members coupled to each other using an intervening member that is integrally formed as a single unitary body with one of the two members. If “coupled” or variations thereof are modified by an additional term (e.g., directly coupled), the generic definition of “coupled” provided above is modified by the plain language meaning of the additional term (e.g., “directly coupled” means the joining of two members without any separate intervening member), resulting in a narrower definition than the generic definition of “coupled” provided above. Such coupling may be mechanical, electrical, or fluidic.

References herein to the positions of elements (e.g., “top,” “bottom,” “above,” “below”) are merely used to describe the orientation of various elements in the FIGURES. It should be noted that the orientation of various elements may differ according to other exemplary embodiments, and that such variations are intended to be encompassed by the present disclosure.

The hardware and data processing components used to implement the various processes, operations, illustrative logics, logical blocks, modules and circuits described in connection with the embodiments disclosed herein may be implemented or performed with a general purpose single- or multi-chip processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, or, any conventional processor, controller, microcontroller, or state machine. A processor also may be implemented as a combination of computing devices, such as a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. In some embodiments, particular processes and methods may be performed by circuitry that is specific to a given function. The memory (e.g., memory, memory unit, storage device) may include one or more devices (e.g., RAM, ROM, Flash memory, hard disk storage) for storing data and/or computer code for completing or facilitating the various processes, layers and modules described in the present disclosure. The memory may be or include volatile memory or non-volatile memory, and may include database components, object code components, script components, or any other type of information structure for supporting the various activities and information structures described in the present disclosure. According to an exemplary embodiment, the memory is communicably connected to the processor via a processing circuit and includes computer code for executing (e.g., by the processing circuit or the processor) the one or more processes described herein.

The present disclosure contemplates methods, systems and program products on any machine-readable media for

accomplishing various operations. The embodiments of the present disclosure may be implemented using existing computer processors, or by a special purpose computer processor for an appropriate system, incorporated for this or another purpose, or by a hardwired system. Embodiments within the scope of the present disclosure include program products comprising machine-readable media for carrying or having machine-executable instructions or data structures stored thereon. Such machine-readable media can be any available media that can be accessed by a general purpose or special purpose computer or other machine with a processor. By way of example, such machine-readable media can comprise RAM, ROM, EPROM, EEPROM, or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to carry or store desired program code in the form of machine-executable instructions or data structures and which can be accessed by a general purpose or special purpose computer or other machine with a processor. Combinations of the above are also included within the scope of machine-readable media. Machine-executable instructions include, for example, instructions and data that cause a general purpose computer, special purpose computer, or special purpose processing machines to perform a certain function or group of functions.

Although the figures and description may illustrate a specific order of method steps, the order of such steps may differ from what is depicted and described, unless specified differently above. Also, two or more steps may be performed concurrently or with partial concurrence, unless specified differently above. Such variation may depend, for example, on the software and hardware systems chosen and on designer choice. All such variations are within the scope of the disclosure. Likewise, software implementations of the described methods could be accomplished with standard programming techniques with rule-based logic and other logic to accomplish the various connection steps, processing steps, comparison steps, and decision steps.

It is important to note that the construction and arrangement of the wheel grid **100** and the systems and components thereof as shown in the various exemplary embodiments is illustrative only. Additionally, any element disclosed in one embodiment may be incorporated or utilized with any other embodiment disclosed herein. Although only one example of an element from one embodiment that can be incorporated or utilized in another embodiment has been described above, it should be appreciated that other elements of the various embodiments may be incorporated or utilized with any of the other embodiments disclosed herein.

The invention claimed is:

1. A wheel grid comprising:

a crossbar configured to be coupled to a main boom of a wheel lift tow vehicle;

a first L-arm comprising a first extension member and a first wheel brace member, the first extension member rotatably coupled to the crossbar at a first pivot point;

a second L-arm comprising a second extension member and a second wheel brace member, the second extension member rotatably coupled to the crossbar at a second pivot point;

a first crossbar end coupled to a first end of the crossbar adjacent a proximal end of the first crossbar end and configured to engage a first tire of a towed vehicle, the first crossbar end comprising a first cantilevered portion adjacent a distal end of the first crossbar end; and a second crossbar end coupled to a second end of the crossbar adjacent a proximal end of the second crossbar



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end and configured to engage a second tire of the towed vehicle, the second crossbar end comprising a second cantilevered portion adjacent a distal end of the second crossbar end;

wherein the first and second L-arms are configured to rotate into a stowed position in which the first wheel brace member is positioned under the first cantilevered portion and the second wheel brace member is positioned under the second cantilevered portion.

**2.** The wheel grid of claim 1, wherein:

the first and second extension members are rotatably coupled to the crossbar at respective proximal ends;

a distal end of the first extension member is coupled to a proximal end of the first wheel brace member and a distal end of the second extension member is coupled to a proximal end of the second wheel brace member; and

the first wheel brace member extends substantially perpendicularly away from the first extension member and the second wheel brace member extends substantially perpendicularly away from the second extension member.

**3.** The wheel grid of claim 2, wherein in the stowed position, the first and second extension members are positioned substantially parallel and adjacent to the crossbar and the first and second wheel brace members extend in a direction substantially perpendicular to the crossbar.

**4.** The wheel grid of claim 2, wherein the L-arms are configured to rotate into a loading position in which the extension members are substantially parallel and adjacent to the crossbar and the first wheel brace member is substantially parallel and adjacent to the second wheel brace member.

**5.** The wheel grid of claim 4, further comprising a linear actuator coupled to one or more linkages, the linear actuator and the one or more linkages configured to rotate the first L-arm approximately 180 degrees from the stowed position to the loading position.

**6.** The wheel grid of claim 2, wherein the first and second wheel brace members are substantially straight.

**7.** The wheel grid of claim 1, wherein the distance from the first pivot point to the first wheel brace member is less than the distance from the first pivot point to a distal end of the first crossbar end.

**8.** The wheel grid of claim 1, further comprising:

a mounting bracket coupled to the crossbar, the mounting bracket configured to be rotatably coupled to the main boom via a rotation pin; and

a detent assembly coupled to the crossbar and configured to engage a detent flat on the main boom to resist the rotation of the wheel grid relative to the main boom when the crossbar is perpendicular to the main boom.

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**9.** The wheel grid of claim 8, wherein the detent assembly comprises:

a detent bracket slidably coupled to two fasteners, the two fasteners coupled to the crossbar; and

two springs, each spring positioned around one of the two fasteners and configured to bias the detent bracket away from the crossbar.

**10.** The wheel grid of claim 9, wherein the fasteners are threadedly coupled to the crossbar and wherein the detent assembly further comprises two locknuts, each locknut configured to restrict the rotation of one of the fasteners.

**11.** A tow vehicle comprising:

a tow vehicle frame;

a main boom coupled to the tow vehicle frame and extending rearward from the tow vehicle frame; and

a wheel grid rotatably coupled to the main boom by a rotation pin, the wheel grid comprising:

a crossbar configured to be coupled to the main boom;

an L-arm comprising an extension member and a wheel brace member, the extension member rotatably coupled to the crossbar at a pivot point; and a

crossbar end coupled to an end of the crossbar adjacent a proximal end of the crossbar end and configured to engage a tire of a towed vehicle, the crossbar end comprising a cantilevered portion adjacent a distal end of the crossbar end;

wherein the L-arm is configured to rotate into a stowed position in which the wheel brace member is positioned under the cantilevered portion.

**12.** The tow vehicle of claim 11, wherein:

a proximal end of the extension member is rotatably coupled to the crossbar

a distal end of the extension member is coupled to a proximal end of the wheel brace member; and

the wheel brace member extends substantially perpendicularly away from the extension member.

**13.** The tow vehicle of claim 12, wherein in the stowed position, the extension member is positioned substantially parallel and adjacent to the crossbar and the wheel brace member extend in a direction substantially perpendicular to the crossbar in a forward direction under the tow vehicle frame.

**14.** The tow vehicle of claim 11, wherein the distance from the pivot point to the wheel brace member is less than the distance from first pivot point to a distal end of the crossbar end.

**15.** The tow vehicle of claim 11, wherein the wheel grid is configured to rotate at least 180 degrees about the rotation pin.

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